Forest Insect and Disease Conditions in Canada 1987

Forestry Canada Forêts Canada

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Contents

Page

Introduction 1

Summary of Defoliation and Damage Estimates 3

Major Forest Insects and Diseases 5

Spruce budworm 5
Western spruce budworms 10
Western blackheaded budworm 13
Jack pine budworm 14
Mountain pine beetle 15
Spruce beetle 18
Eastern larch beetle 19
Gypsy moth 19
Forest tent caterpillar 23
Hemlock looper 26
Dutch elm disease 28
Scleroderris canker 30
European larch canker 31
Decline and dieback and stress-related disorders 32

Special Surveys 36

Cone and seed pests 36
Pinewood nematode 37
Stillwell's Syndrome 39

Acid Rain National Early Warning System 41

Pests in young stands and plantations 44

Selected Bibliography 53

Other Insects, Diseases, and Damage 59

Newfoundland region 60
Maritimes region 64
Québec region 77
Western and Northern region 81
Pacific and Yukon region 86

Introduction

The Forest Insect and Disease Survey is a nationally coordinated program of six regional FIDS units and the FIDS Technology Development Project. Activities are managed by the regional Canadian Forestry Service (CFS) establishments. The program provides perspectives on insects and disease, including effects of acid rain, to forest managers, quarantine agencies, researchers, educators, and the public. Significant changes are now being made to FIDS through its new Strategic Plan. The FIDS Strategic Plan defines the role of FIDS and its responsibilities in relation to other federal and provincial agencies. It also provides guidance for FIDS program development and activities over the next several years. The levels of provincial and industry involvement and their roles in Forest Insect and Disease Surveys are becoming increasingly diverse. Therefore, the advantages of delegating routine field survey activities to the provinces are countered by the need to maintain the capacity to carry out federal mandates.

The proposed strategic direction for FIDS includes:

1) Intelligence gathering: analysis and generation of knowledge, and forecasting;

2) Identification of federal/provincial survey responsibility;

3) Identification and establishment of the FIDS role in the Plant Quarantine Act and in interprovincial and international marketing relationships.

Forest Insect and Disease Conditions in Canada 1986 is the seventh in a series of national annual reports of the Forest Insect and Disease Survey. In cooperation with those responsible for improving forest inventory and economic data in Canada, the survey is attempting to provide more quantitative and interpretive data on damage and depletion caused by forest pests. The new initiative requires the development of methodologies and procedures before complete and accurate data can be made available. As forest management intensifies and old growth forests are gradually replaced by new, managed forests, new pest problems and impacts will arise and require increased attention (for example, the spruce budmoth). Accordingly, regional and national reporting will continue to be modified to reflect the changing activities and findings of the survey.

This report is produced through a cooperative effort of the six CFS regional establishments. The 1985 report introduced the FIDS Technology Development Project, which coordinates technology development for FIDS. Based at the Petawawa National Forestry Institute (PNFI), the project draws on the strength of resident expertise in computing, data analysis, remote sensing, and modeling in support of FIDS activities.

In this report, pests considered to be currently significant in terms of their present or potential economic, sociological, or environmental impact are described in detail under "Major Forest Insects and Diseases". Regional surveys of pest problems in special situations or of specific pests are summarized under "Special Surveys". The status of many other pests is presented in tabular form by region under the title "Other Insects, Diseases, and Damage". Although they do not, in most cases, have spectacular effects, they are important because of their potential for expansion, quarantine considerations, their possible role as vectors, and as indicators of other problems. Additional information on these and other pests can be obtained from regional forestry centers of the Canadian Forestry Service.

There are several insidious forest pests in Canada that are not amenable to routine detection surveys and, therefore, escape annual census; nevertheless, they do cause significant losses. This report recognizes the importance of these pests through periodic descriptive, if not quantitative, reviews.

As much as possible in this report we have used current nomenclature and authorship to designate pest species. Because the taxonomy of some species changes occasionally and old names tend to persist, we have striven to realistically balance clear communication to our audience and incorporation of taxonomic revision.

In recent years we have personalized the cover of this report by showing some of our personnel in action.

In addition to those already named we would like to acknowledge the field and laboratory staffs of the forest centres, officers of provincial and federal governments and agencies, the forest industry, and private individuals. The ministère de l'Énergie et des Ressources Québec, Service de la protection contre les insectes et les maladies (SPIM) provided most of the information from Québec, except the pinewood nematode survey and balsam fir special survey, which was done through the FIDS unit at the Laurentian Forestry Centre of the CFS. Finally, we thank those who provided us with comments and suggestions on previous reports.

B.H. Moody
A/Director of Scientific Surveys and Scientific Information

Summary of Defoliation and Damage Estimates

A summary of areas affected in 1987 by major defoliating insects or bark beetles is presented in Table 1 to illustrate the magnitude of the problems. This is done in full realization that strict comparison is not possible: usually a succession of defoliation years is required to kill a tree, and this varies with the pest, the tree species being attacked, and other factors, some of which may be poorly understood. As well, growth losses incurred as a result of pests and the factors influencing these losses are even less well known. Differences in survey methodologies for each pest further complicate comparisons.

Table 1. Selected Major Pests: Comparative estimates of areas of most defoliation in 1987 ('000 ha)

Province or territory	Spruce budworm	Jack pine budworm	Mountain pine beetle[a]	Hemlock looper
Newfoundland	4	-	-	150
Prince Edward Island	0	-	-	-
Nova Scotia	0	-	-	-
New Brunswick	430	0	0	0
Québec	740	-	-	-
Ontario	7190	505	-	-
Manitoba	15	<1	-	-
Saskatchewan	32	2	-	-
Alberta	6	<1	-	-
Northwest Territories	3	-	-	-
British Columbia[b]	59[c]	-	66	-
Total	8420	508	66	150

[a]Areas where beetle-killed trees occurred.
[b]Western spruce budworm caused light-to-moderate defoliation on an additional 834 000 ha.
[c]Light-to-moderate defoliation.
Erratum: In the 1986 Report, under spruce budworms for British Columbia, 695 should read 95..

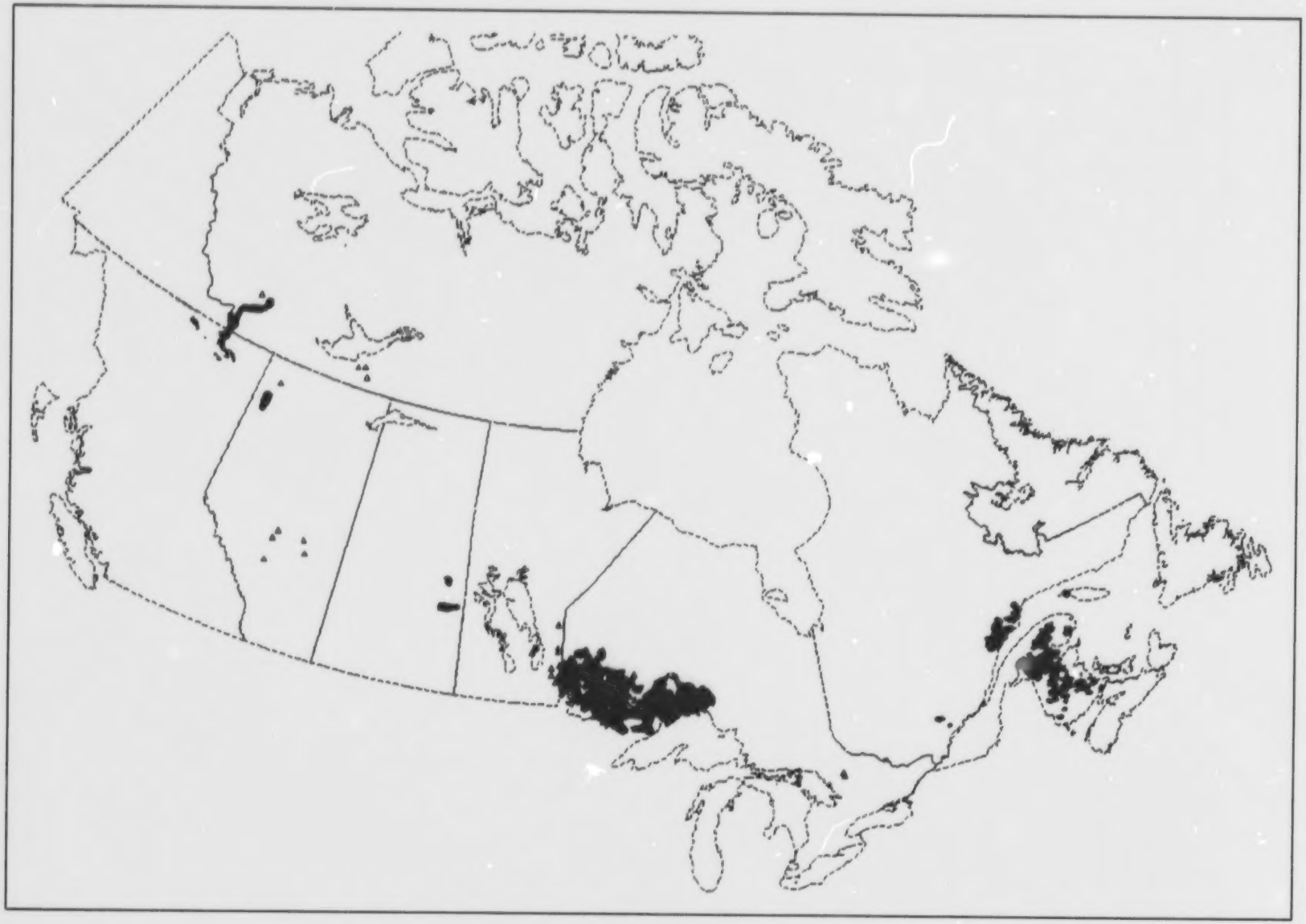

Figure 1: Areas of moderate-to-severe defoliation by the spruce budworm, 1987.

Major Forest Insects and Diseases

Spruce budworm

Choristoneura fumiferana (Clem.)

The spruce budworm remains as Canada's most destructive forest pest. Balsam fir is the preferred host of the spruce budworm although it feeds heavily on red spruce, white spruce and, to a lesser extent, on black spruce. At very high population levels, this budworm will also attack hemlock and larch. In 1987, populations continued to decline and the area within which moderate-to-severe defoliation occurred decreased to 8.4 million ha (Figure 1), from 12.3 million ha for 1986. Spruce budworm populations and the area of defoliation have shown a marked downward trend in eastern North America during the last few years. In Newfoundland the population increased slightly. In the Maritime Provinces, 1987 showed the smallest area of severe and moderate defoliation in the 20-year history of budworm occurrence. For example, in Prince Edward Island and Nova Scotia this was the first time in two decades that there was no defoliation of balsam fir and spruce detectable during aerial surveys. In New Brunswick, the area of moderate-to-severe defoliation was the least since 1976.

In Québec, the infestation continued its spectacular decline with a 63% decrease since 1986. In Ontario, the area and intensity declined slightly (19%). The areas of budworm infestation with moderate-to-severe defoliation decreased in Manitoba and the Northwest Territories, but increased in Saskatchewan and Alberta. The areas of light-to-moderate defoliation also increased in Alberta (new infestations). In British Columbia there was a decrease in areas light to moderately defoliated.

A complete survey of dead and dying trees was not conducted in 1987; however, some regions did report updated figures and there was tree mortality in permanent impact plots. In particular, Ontario continued to report an increase in the area showing tree mortality.

Aerial spray operations were conducted in all provinces from Manitoba eastward, except for Prince Edward Island and Newfoundland, covering a total of 0.8 million ha. Table 2 shows the areas of moderate-to-severe defoliation by province and the areas sprayed to control spruce budworm in 1987. Table 3 shows areas defoliated and sprayed since 1980.

Table 2. Area of moderate-to-severe defoliation by province and area sprayed to control spruce budworm in 1987.

Province	Area of moderate-to-severe defoliation ('000 ha)	Area sprayed ('000 ha)
Newfoundland	3.6	0
Prince Edward Island	0	0
Nova Scotia	0	31.1
New Brunswick	430.0	584.3
Québec	739.7	205
Ontario	7189.7	76.7
Manitoba	15.5	*
Saskatchewan	31.6	0
Alberta	5.8	*
Northwest Territories	2.6	0
Total	8418.5	897

*Less than 1000 ha.

Table 3. Area of moderate-to-severe defoliation and area sprayed to control spruce budworm since 1980 in Canada.

Year	Area of moderate-to-severe defoliation ('000 ha)	Area sprayed ('000 ha)
1980	36.2	1.9
1981	37.0	2.9
1982	18.2	3.0
1983	23.8	3.1
1984	16.8	2.0
1985	20.2	1.5
1986	12.3	0.8
1987	8.4	0.9

Newfoundland

Defoliation— Population levels remained relatively high and caused moderate-to-severe defoliation in three isolated infestations; one at South Branch, one on the Baie Verte Peninsula, and the third near Ten Mile Lake on the Northern Peninsula. Generally, larval numbers increased throughout western Newfoundland. The area of moderate and severe defoliation covered about 3600 ha. Light defoliation occurred on about 1700 ha.

Control — There was no operational or experimental control program conducted against the spruce budworm in 1987. In 1987 spruce budworm samples were collected from near Baie Verte for biological mortality studies. The main larval parasites were *Glypta fumiferanae* and *Meteorus trachynotus*, causing about 19% mortality. *Ephialtes ontario*, the most common pupal parasite, caused 62% mortality.

Several tachinid parasites also emerged from large larvae and pupae.

The most commonly detected fungal pathogen was *Paecilomyces farinosus*, causing about 1% infection. *Entomophaga aulicae* and *Nosema fumiferanae* occurred less frequently. In addition, about 3% of the budworm samples were infected by a fungus tentatively identified as *Aureobasidium pullulans*. The pathogenicity of this fungus is being investigated.

Pheromone traps were placed at 50 permanent locations throughout Newfoundland and moths were caught at 58% of these. Moths were trapped at every location throughout western Newfoundland. The highest numbers were recorded on the Port au Port Peninsula (118) and near the infestation in the Codroy Valley (87). The number trapped at Sally's Cove (52) remains high for the third year running in spite of a lack of local infestation. Very few moths were trapped in central and eastern Newfoundland, and the number of moths trapped decreased from 1986 to 1987.

Forecast — Sampling was conducted in conjunction with the hemlock looper egg survey in late October. The number of budworm egg samples was increased to 74 this year in western Newfoundland and results showed that 2240 ha of moderate and severe defoliation is expected near South Branch. Light defoliation in isolated patches is forecast to occur from Codroy Valley to George's Lake, on the Baie Verte Peninsula, and near Ten Mile Lake on the Northern Peninsula.

Nova Scotia

Defoliation — For 1987, for the first time in more than two decades, there was no defoliation of balsam fir or spruce detectable during the annual spruce budworm aerial survey in Nova Scotia. Small groups of trees still supported low populations of spruce budworm at scattered locations in the Province and trace-to-light defoliation was detected during ground surveys. The highest level of defoliation recorded was 28% on balsam fir south of Tignish Bridge and 15% on white spruce at Wallace in Cumberland County.

Damage — There were no specific budworm damage surveys conducted by the Forest Insect and Disease Survey in Nova Scotia in 1987.

Control — Control operations in Nova Scotia were conducted by the Nova Scotia Department of Lands and Forests on 31 080 ha. The biological control agent *Bacillus thuringiensis* (B.t.) (Dipel® 132), at the rate of 30 BIU/ha, was the only control agent used. All but 98 ha were treated aerially.

Forecast — The overwintering larval (L2) survey was conducted by the Nova Scotia Department of Lands and Forests, with sampling assistance from Bowater-Mersey Ltd. personnel.

Information from 430 sample locations indicates that the spruce budworm population is collapsing. L2 populations were zero at 61%, low at 33%, moderate at 4%, high at 1.5%, and extreme at only 0.5% of the locations sampled. Moderate or higher populations were found only in Antigonish, Colchester, Cumberland, and Pictou counties. Defoliation, if any, in 1988 is expected to be confined to small, isolated patches of fir and spruce stands in these counties.

Prince Edward Island

Defoliation — In 1987, for the first time since 1968, there was no defoliation of balsam fir or spruce detectable during the annual spruce budworm aerial survey in Prince Edward Island. Ground surveys detected defoliation of varying intensity in small patches of forest, on individual trees or, in some cases, on individual branches in numerous areas throughout the Province, mostly in eastern Queens and southern Kings counties and in a white spruce stand near Little Sands, Kings County.

Damage — There were no specific spruce budworm damage surveys conducted by the Forest Insect and Disease Survey in Prince Edward Island in 1987.

Control — No control measures on an operational scale were carried out against the spruce budworm in Prince Edward Island in 1987.

Forecast — The overwintering larval (L2) survey was conducted by the Canadian Forestry Service. Information from the 38 locations indicates that spruce budworm populations in 1988 are likely to be even lower than experienced in 1987; consequently no significant defoliation of fir or spruce is expected. Populations were extreme at 5%, moderate at 21%, low at 63%, and nil at 11% of the locations sampled.

New Brunswick

Defoliation — Defoliation of balsam fir and spruce stands was recorded on 518 000 ha in the province. Defoliation was severe on 241 000 ha, moderate on 189 000 ha, and light on 88 000 ha. The 430 000 ha of severe and moderate defoliation was the least extensive since 1976. Defoliation was scattered around the province, with the largest concentrations of moderate and severe defoliation in the northcentral, northwestern, and central areas.

Damage — There were no specific spruce budworm damage surveys conducted by the Forest Insect and Disease Survey in New Brunswick in 1987.

Control — Foliage protection against the spruce budworm in New Brunswick was conducted over 584 600 ha in 1987: 478 300 ha by Forest Protection Ltd. and 106 300 ha by Forest Patrol Ltd.

Forest Protection Ltd. treated 358 700 ha with two applications of fenitrothion (Sumithion®), 81 700 ha with the biological control agent B.t. (Dipel® 132 and Futura®), 28 300 ha with aminocarb (Matacil® 180F) followed by an application of fenitrothion, and 9600 ha with fenitrothion

followed by an application of B.t. The rates of application were 210 g/ha or 140 g/ha for fenitrothion, 70 g/ha for aminocarb, and 30 BIU/ha for B.t. Most of the chemical treatments were applied in water-based formulations while B.t. was applied undiluted.

Forest Patrol Ltd. treated 89 000 ha with aminocarb (Matacil® 180F), 16 300 ha with fenitrothion, and 1000 ha with the biological agent B.t. (Futura® S.C.). All but 2% of the 106 000 ha treated received two applications. Application rates were 90 g/ha for aminocarb, 210 g/ha for fenitrothion, and B.t. was applied undiluted at 2.1 L/ha. All aminocarb, and 84% of the fenitrothion in the first application and 4% in the second application, were dispensed at UULV rates.

Forecast — The overwintering larval (L2) survey was conducted by the New Brunswick Department of Natural Resources and Energy at 1572 locations. L2 populations of spruce budworm were low at 76%, moderate at 15%, and high at 95 of the areas sampled. There was a three-fold increase in the proportion of points in the high category compared to 1986 results; intensification occurred in the northcentral and northwestern part of the province. The forecast for 1988 is for 1.5 million hectares of moderate-to-severe defoliation. The most severe damage is expected to occur in the northern part of New Brunswick. No significant damage is expected in the southern third of the Province or throughout much of the western, eastern, and northeastern areas.

Québec

Defoliation — In 1987, the spruce budworm infestation continued its spectacular decline in the administrative regions of Montréal, Trois-Rivières, Québec, and Saguenay—Lac-Saint-Jean (Table 4). Budworm populations dropped dramatically throughout central Québec and no damage was detected in the regions of Saguenay—Lac-Saint-Jean, Estrie, Outaouais, and Abitibi - Témiscamingue. Infestation levels were substantially lower in all regions except theBas-Saint-Laurent—Gaspésie where the insect maintained its hold. A decline in population was noted, however, along the north side and eastern portion of the Gaspé Peninsula. Despite the sharp decline in infestation in several areas of the Côte-Nord region, damage due to the spruce budworm was still severe.

The infestation covered an area of 1.07 million ha in 1987 compared to 2.83 million ha in 1986 (Table 4). Damage was light over 0.30 million ha, moderate over 0.35 million ha, and severe over 0.39 million ha. The drop recorded in 1987 constitutes a 63% decrease in budworm-infested areas over the 1986 figure. Since 1983, budworm-infested areas have steadily dwindled over the years, with infestation declining from a total of 13.21 million ha in 1983 to 11.04 million ha in 1984, 9.26 million ha in 1985, and to 2.83 million ha in 1986. This corresponds to a 16% drop in both 1984 and 1985 and a 69% decline in 1986.

In southern and eastern Québec, budworm populations also continued to dwindle in 1987, especially in some light-to-moderate pockets that had persisted in 1986 on the south shore of the St. Lawrence, e.g. between Saint-Jean-Port-Joli and Trois-Pistoles. No annual defoliation was observed in this area in 1987. Budworm damage was more severe in the Gaspé Peninsula.

As in 1986, infestation was recorded in this area where a sharp increase in numbers has been observed, i.e., in the southern portion of the Rimouski Provincial Reserve. Damage continued to be very severe in 1987 in the area between lakes Rimouski and Mistigougèche, the Patapédia River, and the New Brunswick border. Damage also spread and became more intense in the region bounded by the Patapédia, Restigouche, Matapédia, and Milnikek rivers. East of the Matapédia River, the insect retained its hold throughout the areas south of the Shickshock Mountains and generally caused more serious defoliation than in 1986. Damage was moderate-to-severe in a number of sites located primarily between the Nouvelle and Cascapédia Est rivers. Areas southeast of Lake Casault and in the southern Causapscal Reserve, as well as the Dunière Reserve, were also hard hit by the spruce budworm in 1987. The entire zone south of Gaspé Park was severely infested in 1987. The infestation subsided in the portion north of the Peninsula and damage, by and large, was insignificant throughout the area between Grande-Vallée and Sainte-Anne-des-Monts. Budworm populations dropped in a site in the York River basin which had been classified as moderately infested in 1986, and the damage noted in 1987 between the Grand Pabos, Grande Rivière, and Saint-Jean rivers was both less widespread and less intense than in 1986. There was still moderate defoliation over a substantial portion of this area.

The spruce budworm still caused significant damage in the Côte-Nord region in 1987 despite a decrease in budworm numbers in several locations of the region. There was moderate-to-severe defoliation over areas between the Sault aux Cochons River, Labrieville, the Manic 3 dam, and Hauterive. The infestation, however, covered a smaller area in 1987 than in 1986. It was mainly the fringe around the 1986 infestation zone that was spared in 1987. Decline was pronounced between the Portneuf and Sault aux Cochons rivers. No damage was recorded in 1987, although moderate to severe defoliation occurred in 1986. Despite the budworm's hold over wide stretches between Baie-Comeau and Port-Cartier, these areas were smaller in 1987 than in 1986. The decline in the budworm population was significant between the Manic 2 Reservoir and the la Trinité River. Some areas where the insect continued to thrive in 1987 were strongly affected and had moderate-to-severe defoliation. These areas occurred between the aux Anglais and Franquelin Branche Ouest rivers and the municipality of Franquelin, as well as southwest of Lake Pentecôte and south of Lake Walker.

On Anticosti Island, the infestation continued to make inroads. Damage became more acute in the area where the insect had been confined since 1985, i.e. between lakes Geneviève and aux Cailloux. Defoliation was moderate-to-

Table 4. Area (ha) of spruce budworm infestation in the Québec administrative regions, excluding areas of mortality.

Administrative regions	Level of infestation			
	Light (ha)	Moderate (ha)	Severe (ha)	Total (ha)
Bas-Saint-Laurent—Gaspésie	240 344 (315 314)*	232 269 (322 032)	93 722 (56 094)	566 335 (693 440)
Saguenay—Lac-Saint-Jean	- (26 662)	- (32 656)	- (13 282)	- (72 600)
Québec	156 (36 721)	- (100 782)	- (41 095)	156 (178 598)
Trois-Rivières	29 063 (274 208)	8594 (440 980)	- (81 814)	37 657 (797 002)
Estrie	- -	- -	- -	- -
Montréal	2969 (43 281)	1094 (255 626)	- (35 313)	4063 (334 220)
Outaouais	- -	- -	- -	- -
Abitibi - Témiscamingue	- -	- -	- -	- -
Côte-Nord	29 340 (55 558	111 957 (199 694)	292 146 (500 835)	433 443 (756 087)
Province	301 872 (751 744)	353 914 (1 351 770)	385 868 (728 443)	1 041 654 (2 831 947)

severe in 1987 compared to 1986. New sites were also infested in 1987 (light-to-moderate infestation) primarily in the stretches between the aux Cailloux and à la Loutre rivers and between the Jupiter and Brick rivers.

Control — In 1987, the ministère de l'Énergie et des Ressources Québec carried out its 18th Aerial Insecticide Spraying Program aimed at combating the spruce budworm. A total area of 197 992 ha of forest land in the Bas-Saint-Laurent—Gaspésie (176 429 ha) and Côte-Nord (21 563 ha) regions was sprayed. Due to the increase in levels of infestation in the Bas-Saint-Laurent—Gaspésie region, spraying operations in 1987 covered virtually four times the area treated in 1986.

Only the biological insecticide *Bacillus thuringiensis* var. Kurstaki was used in 1987. It was applied at a rate of 30 BIU/ha in a volume of 2.3 litres/ha. Dipel® 132 was applied over the entire region except for 927 ha which were treated with Dipel® 176. Four 4-engine DC-4s and four single-engine airplanes (two Bull Thrushes and two Turbo Thrushes) conducted spraying operations from May 31 to June 18.

As a result of treatment 19% to 55% of the annual foliage was protected, depending on the area. Only 8% of the treated land suffered severe defoliation. The most marked impact of treatment involved a substantial drop in predicted 1988 larval numbers wherever treatment was effected in 1987. Beyond the boundaries of these treated areas, the forecast for 1988 generally points to an increase in larval numbers. Close to half of the sites treated in 1987 are considered, however, to have received poor protection. These mixed results have been attributed to high local larval populations, delays in applying insecticides, inadequate insecticide deposits, the failure of Dipel® 132 to readily form an homogeneous solution, and to the possible loss of budworm vitality.

The private forests of eastern Québec have been seriously affected by spruce budworm outbreaks. In trying to answer repeated requests from private woodlot owners in eastern Québec, the Canadian Forestry Service developed a protection program through the Eastern Québec Development Plan, Forest Program. Three wood producer associations from the region agreed to carry out the program.

Two phases were carried out: an experimental spray with *Bacillus thuringiensis* over 3800 hectares in 1984, which aimed at developing methods, and two operational dispersions over 30 925 hectares in 1985 and 14 629 hectares in 1986. The 1987 spray program was conducted over 7100 hectares with B.t. (Futura®).

Forecast — On the basis of estimated overwintering populations and a network of pheromone-baited traps, it was possible to predict spruce budworm infestation levels for 1988. Data collected from both types of surveys provided evidence that budworm populations would be low across Québec except in the Bas Saint-Laurent—Gaspésie region and some areas in the Trois-Rivières and Côte-Nord regions.

A survey of overwintering larval populations (L2) was conducted in 1529 sample plots scattered mainly throughout the areas east of the Montréal administrative region. Here, as well as in the Trois-Rivières administrative region, the survey was carried out only where budworm had caused damage in 1987. Findings show that budworm populations will remain at low-to-moderate levels in a few stands near Saint-Côme and Sainte-Émilie-de-l'Énergie (Montréal administrative region). In the Trois-Rivières region, the survey indicates that pockets of moderate-to-high populations will persist in the southwestern portion of the Saint-Maurice Wildlife Reserve (à la Chienne River, south of Lake Normand) as well as in the southern segment of La Mauricie National Park (lakes Shawinigan and Wapizagonke) and south of the municipality of Rivière-aux-Rats. In the Bas-Saint-Laurent—Gaspésie region, the forecast is for serious budworm damage in most of the areas south of Lake Matapédia and between the Rimouski and Petite Cascapédia Est rivers. Budworm populations rose sharply over this area. In 1988, the infestation is expected to spread throughout those regions infested in the Gaspé Peninsula in 1987, and damage will be more intense. After a few years of lowered budworm activity, several locations north of the Shickshock Mountains and in the southern Gaspé Peninsula, i.e., between New Richmond and Cap-d'Espoir, will once again be infested with the insect. Lastly, the epidemic will continue to be pronounced over several areas on the North Shore, despite a marked regression in relation to 1987 findings. Areas between the Sault aux Cochons and aux Outardes rivers, as well as a number of pockets between the Manic 2 Reservoir and Godbout River, will suffer moderate-to-severe infestation in 1988.

Ontario

Defoliation - The area and intensity of spruce budworm defoliation declined in 1987. A total of 7 189 763 ha of moderate-to-severe defoliation was mapped, a reduction of 19% from the 1986 findings. Most of the decline occurred in the eastern section of the outbreak particularly in the Hearst, Wawa, Geraldton, and Terrace Bay districts. A small increase of about 50 000 ha occurred along the northern edge of the infestation in Ignace, Sioux Lookout, and Red Lake districts. The bulk of this year's defoliation consisted of two large pockets, one of 4.6 million ha stretching from the Manitoba border eastward to the Devon-Fowler townships area of Thunder Bay District, and the other 2.3 million ha from the eastern Thunder Bay District through the Nipigon District to the southwestern Geraldton and western Terrace Bay districts. A number of other pockets (41) occurred, mainly along the northern edge of the infestations, with a few in the southern Fort Frances District.

Throughout much of the area affected, defoliation, while still in the moderate-to-severe category, was considerably reduced over 1986. Part of the reason for this may have been the severe frosts which occurred in northwestern Ontario on May 22nd and 24th when budworm larval populations may have been vulnerable to low temperatures.

Damage — Surveys in the latter part of the field season revealed an area of 14 067 082 ha within which budworm-caused mortality occurred. This was an overall increase of 82 174 ha over the 1986 figure. A large part of the increase occurred in the southwest Thunder Bay District, with most of the remainder consisting of small scattered pockets in the Ignace, Atikokan, southern Dryden, and eastern Fort Frances districts. A few small scattered pockets were also evident in the Black Sturgeon Lake area of the adjoining Nipigon and Thunder Bay districts as well as in the southern Terrace Bay and southeastern Geraldton districts.

Control — The Ontario Ministry of Natural Resources (OMNR) aerially treated 76 689 ha of white spruce and balsam fir stands. Most of the area (76 526 ha) was in the North Central Region and the remaining 163 ha was in the Northwestern Region. This was a considerable reduction from the 147 000 ha treated in 1986. The spraying program included commercial forest, along with high value stands such as provincial parks and selected plantations. The bacterial insecticide *Bacillus thuringiensis* was used exclusively, with single or double applications of Dipel® 132 applied at rates of either 20 BIU/1.6L/ha or 30 BIU/2.3L/ha. Both fixed-wing aircraft and helicopters were used to deliver the insecticide. Spraying began on May 23 and was completed on June 13.

Forecast — The 1987 egg-mass sampling program showed an overall decline of 47% in egg-mass densities. As a result, no defoliation of any consequence is expected in the Northern and Northeastern regions and in southern Ontario. In the North Central Region, east of Lake Nipigon, defoliation will probably decline to light with occasional patches of moderate-to-severe damage in the eastern Nipigon, Geraldton, and Terrace Bay districts. In the same region west of Lake Nipigon, moderate-to-severe defoliation will probably persist from the west side of the lake, southwestward to Black Bay on Lake Superior in the western Nipigon and Thunder Bay districts. Additional pockets of moderate-to-severe defoliation are expected in the Lac des Mille Lacs area and along the U.S. border in Thunder Bay District. In the Northwestern Region, despite a decline of 41%, overall egg-mass densities were sufficiently high that moderate-to-severe defoliation will probably persist in much of the area infested in 1987, with some possible expansion south of Trout Lake in the Red Lake District.

Manitoba

Defoliation — A decline in areas defoliated by the spruce budworm occurred for the second consecutive year in 1986. Moderate to severe defoliation of white spruce and balsam fir was mapped over 15 540 ha compared to 34 318 ha in 1986, a reduction of 55%. Nearly all areas infested occurred in the southeast part of the province, with the highest populations and largest increase in defoliated areas in Whiteshell Provincial Park.

Control — Areas treated were high value areas at Dorothy and Falcon lakes in Whiteshell Provincial Park in southeastern Manitoba.

Forecast — Egg-mass sampling and moth counts at several locations, conducted by the CFS and Manitoba Department of Natural Resources, indicated that moderate-to-severe defoliation may occur in the Lake Winnipeg East forest section in 1988. Other infested forest sections are forecast to have nil, light, or moderate defoliation in 1988, based on egg-mass density counts. Spruce budworm moth captures in pheromone-baited traps in 1987 indicated declining trends, compared to 1986, at 12 of 13 sites monitored.

Saskatchewan

Moderate-to-severe defoliation of white spruce and balsam fir occurred in the Red Earth and Porcupine Hills areas in the east-central part of the province, and amounted to a total of 31 600 ha, an increase of about 170% over last year. Severe defoliation within some of these areas has been continuous since 1982 and 1983.

In the Porcupine Hills infestations south of Hudson Bay, moderate-to-severe defoliation of white spruce stands extended over 16 600 ha between Reserve and Usherville, westward to Big Valley Lake, and eastward to White and Decorby lakes. Additional areas of light defoliation occurred between Eagle Lake and Piwei River and between Swallow and Parr Hill lakes. In the Red Earth infestations the total area of moderate-to-severe defoliation was 15 000 ha, somewhat higher than last year. Extensions of the boundaries occurred northwest of the Carrot River and south of Highway 55. Timber harvesting is in progress in both infested areas to salvage budworm-damaged trees.

Egg-mass density estimates and male moth captures in pheromone-baited traps at six locations indicate that a general decline to light or moderate levels may occur in 1988 in at least five of the six monitoring sites.

Alberta

Defoliation — Small infestations causing moderate-to-severe defoliation occurred again in Big Knife Provincial Park (100 ha), near Castor (200 ha), near Morningside along Bigstone Creek (50 ha), and near Red Lodge Provincial Park (10 ha). Additional areas of light defoliation occurred in Edmonton along the North Saskatchewan River (100 ha), near Millet (250 ha), and in Red Lodge Provincial park (30 ha).

In northwestern Alberta a new outbreak causing moderate-to-severe defoliation over 5400 ha occurred along the Chinchaga River, west of High Level. An additional area of 3690 ha of light defoliation occurred within the same area, while light-to-moderate defoliation of about 100 ha occurred along the Steen River.

Control — Areas treated were high value sites in Big Knife Provincial Park and near Millet and Morningside in central Alberta.

Forecast — Egg-mass density counts at several locations in the Footner Lake Forest indicate moderate-to-severe defoliation will occur in 1988 in the Chinchaga River outbreak area, while light defoliation will occur at Steen River.

Northwest Territories

The spruce budworm infestation along the Liard River extended over much the same white spruce stands as in 1986, extending from the B.C. border north to the confluence of the Liard and MacKenzie rivers, and west along the south side of the river to the confluence of the Martin River. A slight expansion of the area of outbreak occurred west of Fort Simpson, all classed as light-to-moderate defoliation in 1987, compared to a moderate-to-severe rating in 1986. Scattered pockets of moderate-to-severe defoliation, however, occurred along the Kotaneelee River and south of Fort Simpson. The combined total area mapped with noticeable defoliation was 11 200 ha.

In the outbreak along the Slave River, the overall area affected increased slightly compared to 1986, while the defoliation level declined to light-to-moderate, and extended over about 2000 ha on Long Island and along the adjacent east side of the Slave River. At other areas along the Slave River, near Hook Lake and 10 km north of the mouth of the Salt River, light-to-moderate defoliation extended over an estimated 600 ha. An infestation, first reported on Salt Mountain in 1985, collapsed in 1987.

British Columbia

Defoliation of current foliage of alpine fir and white spruce by spruce budworm was light-to-moderate over 59 400 ha along the Fort Nelson and Liard River valleys in the Prince George Region and into the Northwest and Yukon territories. Light defoliation occurred for the second consecutive year between Coal and Smith rivers, near Liard Hot Springs, and west of Fort Nelson. The infested area mapped by aerial survey declined from the 95 000 ha in 1986, which was the first year of expansion since the mid-1970s. The apparent decrease may have been due, in part, to poor weather which delayed aerial detection surveys by a month and reduced aerially-visible evidence of light budworm feeding. Adult male moths were caught in pheromone-baited non-sticky traps near Fort Nelson and Liard Hot Springs. The numbers of male moths (average 43, range 0 to 102) indicate budworm populations will be variable but will continue in the Fort Nelson area in 1988.

Western spruce budworms

Choristoneura spp.

British Columbia

The western spruce budworm, *Choristoneura occidentalis* Free., is the most widely distributed and destructive defoliator of coniferous forests in western North America. It is a distinctly different species from the eastern spruce budworm and, despite the common name, within British

Columbia feeds primarily on Douglas-fir. Other conifer-feeding budworms currently active in British Columbia include the two-year budworm *C. biennis* Free. and the eastern spruce budworm *C. fumiferana* (Clem.), which extends into northeast British Columbia.

Since 1900, at least six western budworm infestations of varying duration have occurred at irregular intervals in southern British Columbia. The effects of defoliation include loss of radial and height growth, top-kill and resulting defects, and some tree mortality. The Fraser Canyon infestation which started in the late 1960s peaked in 1977 with 214 300 ha defoliated. However, populations then began increasing in drier interior stands from Cache Creek east and now, with more than 800 000 ha infested, it is the most expansive infestation recorded. Mortality of understorey regeneration in these stands, although largely unquantified, is of greater concern than in the wetter zones previously infested.

In 1987 the area of immature and mature Douglas-fir forests in the southwestern interior of British Columbia defoliated by the one-year cycle western spruce budworm doubled to more than 834 000 ha (Figure 2a,b). This is the most extensive outbreak recorded in British Columbia during more than 50 years of forest insect and disease surveys. Nearly all defoliated stands (98%) were in the Kamloops Region.

Overall, 76% of the defoliated areas sustained light defoliation, 22% sustained moderate defoliation, and 2% sustained severe defoliation. The most significant areas of expansion were in the Kamloops Region at the northern limits of the host range near Clearwater and Wells Gray Provincial Park. Smaller expansions occurred around Vernon and west of Penticton in the Okanagan Valley. Areas of Douglas-fir defoliated in 1986, but not this year, totalled more than 76 000 ha; most of the areas of decline (59 000 ha) occurred in the Savona, Ashcroft, and Clinton areas. Contributing factors included starvation, migration, and parasitism.

Less extensive defoliation was recorded in the Cariboo, Nelson, and Vancouver regions. The area of Douglas-fir defoliated by the budworm in the eastern part of the Cariboo Region increased significantly to 9000 ha in 37 separate areas of mainly light defoliation near Quesnel, Horsefly, Canim, and Mahood lakes. In the southern part of the region, over 550 ha of Douglas-fir west of Clinton were moderately defoliated, again after a population decline in 1986. Budworm populations increased once more near D'Arcy in the Vancouver Region and lightly to moderately defoliated Douglas-fir over 2850 ha in 13 areas, up from 1250 ha in 1986. Douglas-fir east of Anarchist Mountain in the Nelson Region were lightly defoliated over 1000 ha, down from 3700 ha in 1986. Undetermined natural factors affected overwintering early-instar larvae.

The last six years of budworm infestations were compared by computer overlays to aid tree condition assessments. Of the total area infested to date 60% has been defoliated for one year, 27% for two consecutive years, 10% for three consecutive years, and 2% for four years. Less than 1% of the total area had been defoliated for five or six years.

Based on egg masses per 10 m^2 of foliage from 10 trees at each of 67 locations, defoliation in 1988 is forecast to be severe in 61% of the stands sampled in the Kamloops and adjacent regions, moderate in 27%, and light in the remainder. Most of the severe defoliation will be in the Kamloops Region in the North Thompson, Adams River, and Okanagan Valley drainages, with smaller areas in the eastern part of the Cariboo Region and east of Anarchist Mountain in the Nelson Region. Light-to-severe defoliation is forecast for the D'Arcy area in the Vancouver Region. In stands defoliated in both 1986 and 1987, defoliation is again predicted, but there was a 31% decrease in the number of egg masses.

Actual defoliation may be less than forecast. Comparisons of predicted and actual defoliation, based on 1986 egg samples and 1987 defoliation at 36 locations in the Kamloops Region, showed agreement at 48% of the sites, less defoliation than predicted at 40% of the sites, and more severe defoliation than predicted in only 12% of the stands.

Parasitism of early- and late-instar larvae occurred at all 28 sites sampled, mostly in the Kamloops Region, and averaged 18% (range 6 to 79%), up 10% from 1986. This was too low to effectively reduce populations. There was no evidence of viral or fungal infections.

Larvae and adult male populations were monitored at 14 locations in four regions to improve and calibrate methods to detect western spruce budworm in Douglas-fir forests. Further data are necessary before numbers can be correlated with population changes and damage.

Mortality of understorey trees, top-kill, and growth loss were evident but variable in stands moderately or severely defoliated for more than four successive years, mostly in the Kamloops Region. Near Ashcroft, mortality of immature and some mature Douglas-fir, a result of about six consecutive years of severe defoliation, was mapped over 540 ha. In 65 plots of open-growing regeneration, mortality averaged 3% (range 0 to 33%) and much of the remainder were severely defoliated. Greater damage exists where regeneration is over-topped by older trees.

An aerial spray trial, conducted by the British Columbia Forest Service and the British Columbia Ministry of Environment and Parks, applied *Bacillus thuringiensis* over about 200 ha of budworm-infested Douglas-fir at Paul Lake Provincial Park near Kamloops and over 10 nearby blocks of immature Douglas-fir totalling 700 ha.

Defoliation of alpine fir and spruce forests in four forest regions by the 2-year-cycle budworm, *C. biennis* Free., was mostly light over 59 750 ha.

Although high numbers were forecast from 1986 egg samples, significant feeding damage was not expected to occur until 1988 when larvae will mature. The mild 1986-87

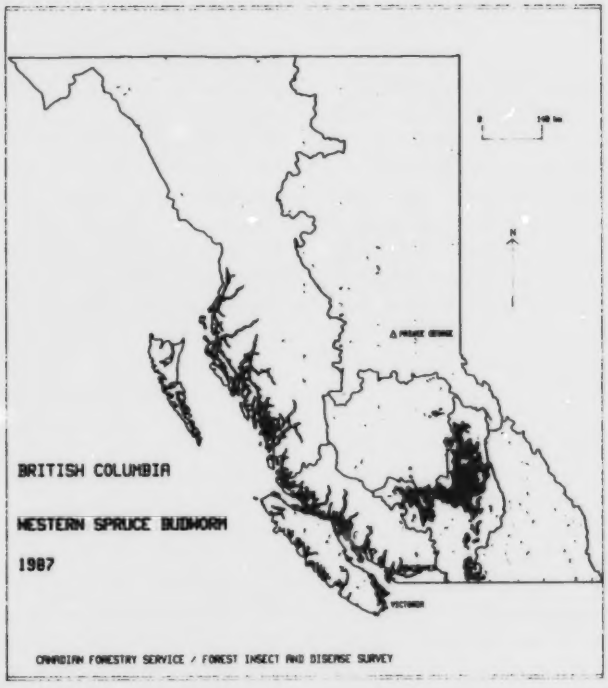

Figure 2a: Area of defoliation by western spruce budworm in British Columbia, 1987.

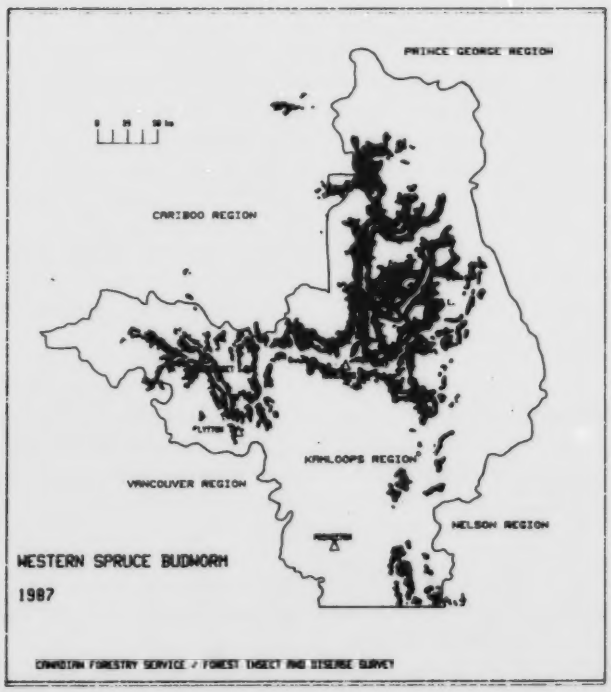

Figure 2b: Area in Figure 2a enlarged to show detail.

winter and warm 1987 spring probably increased larval survival, bud mining, and defoliation intensity.

Most stands defoliated by early instar 2-year-cycle budworm were in the east and southeastern parts of the Prince George Region. Light defoliation in 36 infestations covered 20 000 ha, up 22% from 1986 and up from 580 ha defoliated by similar early-instar larvae in 1985. New infestations developed over 4000 ha northeast of Prince George.

In the northeastern part of the adjacent Cariboo Region, mostly around Quesnel Lake, 78 alpine fir-spruce forests over 11 250 ha were lightly defoliated. Sixty nine separate infestations in the upper North Thompson River drainage covered 17 000 ha, most of which had been also lightly defoliated by mature larvae in 1986.

The high numbers of 2-year-cycle larvae in defoliated fir-spruce stands in the Prince George, Cariboo, and Kamloops regions indicate continuing populations and potentially widespread defoliation in 1988. Immature "off-year" 2-year-cycle budworm larvae defoliated 60 pockets of high-elevation alpine fir-spruce over 11 500 ha in the Nelson Region, mostly in the East Kootenay. As predicted from 1986 egg samples, defoliation in the upper St. Mary River drainage west of Kimberley was severe over 475 ha, moderate in 13 separate infestations over 3500 ha, and light over 5000 ha. West of Invermere, new shoots were lightly defoliated over 700 ha. In the West Kootenay five areas were lightly defoliated over 1650 ha where infestations first developed in the early 1980s. West of Slocan, four pockets of fir-spruce were lightly defoliated for the first time. Based on egg samples in three stands, young larvae are forecast to be numerous in alpine fir and spruce buds in 1988, but are not expected to cause significant defoliation until they mature in 1989.

To improve and calibrate methods to detect budworm in fir-spruce forests, larvae and male adult populations were monitored at 16 locations in three regions. Although up to 200 larvae and 300 males were collected per location, further data are necessary before numbers can be correlated with population changes and damage.

Western blackheaded budworm

Acleris gloverana (Wlshm.),

British Columbia

Western blackheaded budworm has caused extensive defoliation, top-kill, and some tree mortality in western hemlock forests in British Columbia periodically since the 1940s. Infestations occurred in coastal forests of all ages on northern Vancouver Island or the Queen Charlotte Islands in the mid-1940s, 1950s, and early 1970s. Flareups have occurred in interior, usually overmature, wetbelt forests in the mid-1950s, 1960s, and 1980s, but these have subsided without appreciable damage.

In the third consecutive year of the current outbreak on the Queen Charlotte Islands, blackheaded budworm and hemlock sawfly larvae defoliated about 220 separate mature and immature western hemlock stands over an estimated 14 100 ha, about a third of the area affected last year. Additionally, tree mortality following successive years of severe defoliation was mapped over 1500 ha and in widely scattered pockets totalling 2 170 ha throughout defoliated stands. Populations collapsed near Kitimat, near Creston in the Nelson Region, and near McBride in the Prince George Region. New blackheaded budworm infestations developed in hemlock stands in the Kamloops Region over 1100 ha and in a single stand near Holberg on Vancouver Island. In the eastern part of the Prince Rupert Region, from the Nadine River northwest to near Hazelton, most white spruce and alpine fir stands were very lightly defoliated. Budworm populations in the area have been common since 1982, but population levels have fluctuated and little damage has resulted.

Defoliation, mostly on Graham Island, totalled 14 100 ha of which 19% was severe, 61% moderate, and 20% light. In most areas, defoliation was caused primarily by hemlock sawfly feeding on older foliage and budworm defoliating the new foliage. Defoliation of mature western hemlock in mixed hemlock-cedar stands in the Kamloops Region was light in five separate infestations in the upper Clearwater River drainage, in Wells Gray Provincial Park, and in the upper Adams River drainage east of Avola. A single 5-ha pocket of mature hemlock was very lightly defoliated near Holberg. This was the first incidence of defoliation on Vancouver Island since a previous outbreak collapsed in 1973.

Parasitism of blackheaded budworm larvae from Honna River on the Queen Charlotte Islands averaged 6%, which is too low to reduce populations, and less than an average of 16% in three areas in 1986.

Defoliation of western hemlock stands on the Queen Charlotte Islands is forecast to decrease in 1988; defoliation will be severe at only one location, moderate at three, trace or light at 24, and seven sites will be free of defoliation. Assistance in obtaining samples for egg washing from the 35 sites was provided by the British Columbia Forest Service and forest industry personnel. Defoliation of western hemlock is forecast to be severe near Holberg, and light in inaccessible stands in the northern part of Kamloops Region. New shoots of white spruce and alpine fir at seven locations in the eastern part of the Prince Rupert Region could be lightly or moderately defoliated.

Numerous hemlock sawfly cocoons on 50-cm hemlock branches at 11 of 26 sites indicate damaging population levels, mostly on Graham Island, in 1988. Mortality of prepupal sawfly averaged 54% (range 10 to 88%). Infection by the fungus *Entomophthora* occurred at only one site, while viral infection at all sites averaged 14% and parasitism 38%.

Tree mortality estimated during aerial surveys averaged 25% (range 1-80%) in 77 separate infestations totalling 3670 ha, mainly on Moresby Island. About half of these were in 20-

to 100-year-old stands; the remainder were in older stands. Evidence in 1987 of defoliation of previously defoliated tops deferred impact assessments at 10 plots established in 1985 until after the outbreak has collapsed.

Semimature hemlock in plots near Port Alice on Vancouver Island, which were defoliated by blackheaded budworm in 1972-73, were resurveyed this year but showed no evidence of dead trees, tops, or branches. Volume loss through reduced increment is being evaluated.

Jack pine budworm

Choristoneura pinus pinus Free.

This close relative of the spruce budworm has long been regarded a serious pest of jack pine stands and plantations in northwestern Ontario, Manitoba, and Saskatchewan, and the Lake States of the U.S.A. Only in recent years (1967-72) have destructive populations also occurred in central and eastern Ontario and Quebec. Tree mortality of up to 30-40% of the jack pine component in a stand may occur following two to three years of moderate-to-severe defoliation. Top killing is also common and may result in half or more of the stand being damaged.

Infestations of the jack pine budworm in Ontario, (Figure 3) Manitoba, and Saskatchewan virtually collapsed in 1987. Moderate-to-severe defoliation occurred over a total mapped area of 504 749 ha in northwestern Ontario compared to 1 743 725 ha in 1986. In Manitoba and Saskatchewan only 2670 ha were affected, compared to 308 390 ha in 1986. The infestation in Alberta remained much the same as in 1986 with about 70 ha of light-to-moderate defoliation.

Ontario

Defoliation — Jack pine budworm populations completely collapsed in all parts of the province with the exception of the Northwestern Region where some 504 749 ha of moderate-to-severe defoliation were mapped. This was a reduction of 71% from the moderate-to-severe defoliation recorded in 1986. The large areas of moderate-to-severe defoliation which occurred in 1986 broke up into two large pockets and some 350 smaller pockets. The largest pocket (163 532 ha) occurred in the Nungesser Lake area of Red Lake District and the second large pocket (47 172 ha) straddled the Red Lake-Sioux Lookout district boundary in the Aerofoil Lake area. The remaining pockets, ranging in size from a few to several thousand hectares, were scattered throughout the Northwestern Region.

Damage— Approximately 2000 ha of top killing and tree mortality were mapped in scattered pockets in the Red Lake-Barrens Lake area of Red Lake District. Counts of damaged trees in this area showed tree mortality ranging from 2 to 24% and top killing from 0 to 11%. A single evaluation at Norway Lake, Kenora District, disclosed 11% tree mortality and 9% bare tops. Surveys in other areas of the province show that, with the collapse of the infestation, damage levels remain unchanged over those of 1986.

Control — The Ontario Ministry of Natural Resources aerially sprayed 105 463 ha of jack pine stands in the Kenora, Fort Frances, Dryden, and Red Lake districts to protect them from jack pine budworm defoliation. A single application of B.t. in the form of Dipel® 132 was applied at the rate of 20 BIU/1.57L/ha by fixed-wing aircraft. Although spray efficacy was variable from plot to plot, overall results indicate that substantial foliage protection was achieved.

Forecast— The 1987 jack pine budworm egg-mass survey sampled 252 locations, of which 199 were in the Northwestern Region which was the only area where jack pine budworm defoliation was mapped. Analysis of the results indicate an overall decline of 75% in egg-mass densities. The egg-mass surveys indicate that populations have returned to endemic levels in the Northern, North Central, Northeastern, and Algonquin regions and, consequently, no defoliation of any significance is expected in 1988.

In the Northwestern Region, a comparison of 97 locations sampled in 1986 and 1987 revealed a decrease of 73% in egg-mass densities, with significant reductions in all districts of the region. As a result, extensive areas of defoliation are not expected in 1988; however, scattered pockets of light or moderate defoliation will probably persist, particularly in the Nungesser Lake area of Red Lake District and in the central Dryden District.

Québec

Intensive surveys were conducted in 13 jack pine stands in which larvae had been found in 1986. However, no jack pine budworm larvae were found.

In addition, a network of 60 pheromone traps (Multi-Pher I traps) covering 20 sites was set up along the Ontario-Québec border. The network extended from La Sarre (Abitibi) to Fort-Coulonge (Pontiac). Only 15 moths were trapped in the network, 10 of which came from two sites located near Fort-Coulonge. Therefore, this insect does not appear to be present in forests in this region.

Manitoba

The most recent outbreak of the jack pine budworm, first reported in 1982, collapsed in 1987 in all areas except for about 100 ha of moderately to severely defoliated jack pine stands. These stands occurred near Breton and Westhawk lakes in Whiteshell Provincial Park and contrast with the 132 000 ha defoliated in Manitoba in 1986.

Egg-mass samples collected at 20 permanent plot locations in Manitoba indicate that no defoliation will likely occur in 1988 at 14 of the locations and only light defoliation at the other six locations. No control measures of jack pine budworm were undertaken in the province in 1987.

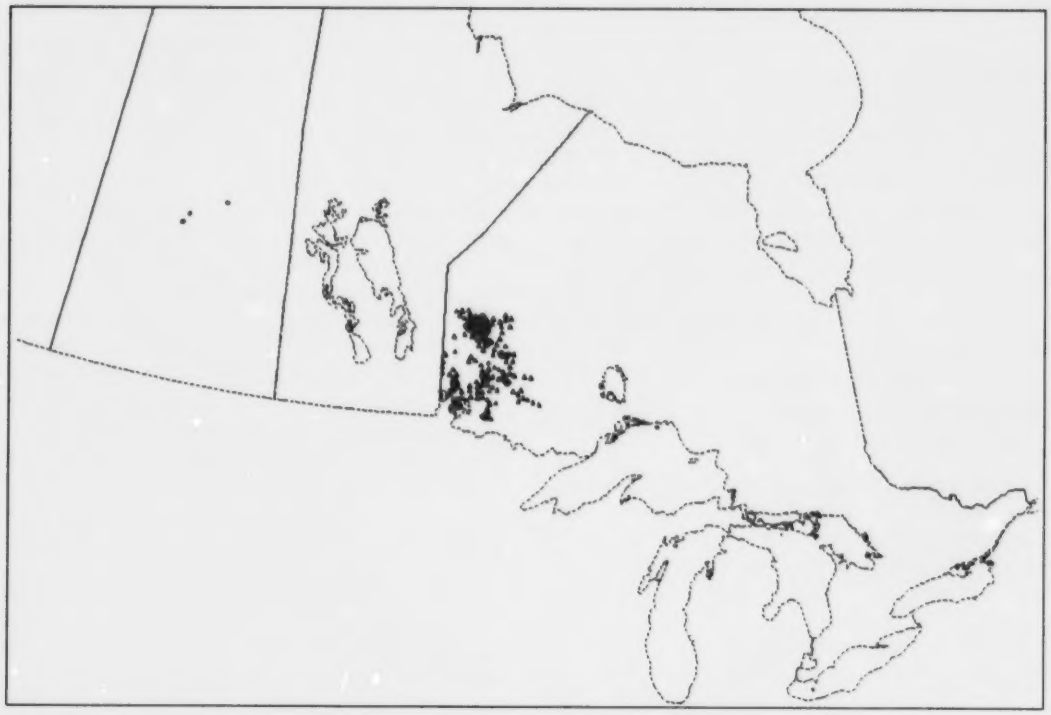

Figure 3: Distribution of jack pine budworm in Ontario, 1987.

The Manitoba Department of Natural Resources conducted a survey of jack pine budworm damaged pine stands near Thompson in 1986 and 1987. Mature jack pine stands in the area had been severely defoliated in 1984 and 1985 and subsequently suffered 17.5% of dead and declining trees, while potential volume loss was estimated as 15.5%. Further decline of the stands is expected to continue in 1988.

Saskatchewan

Moderate-to-severe defoliation of jack pine forests occurred over an estimated 2500 ha in 1987, compared to the 176 000 ha reported in 1986. Most infestations were in pine stands scattered along Highway 106 between Torch River and White Gull Creek (1000 ha) in east-central Saskatchewan and in the Nisbet Provincial Forest (1500 ha), mostly south and southwest of Prince Albert.

Jack pine budworm egg-mass samples collected at nine locations indicate that light or light-to-moderate defoliation will likely occur at three of the locations in 1988.

Alberta

Light-to-moderate defoliation occurred over 70 ha near Tawatinaw and Clyde in central Alberta, all in the same stand locations as reported in 1986. No egg-mass data were obtained to predict infestations for 1988.

Maritime Provinces

The numbers of jack pine budworm moths trapped were as high or higher in 1987 than last year in Kent, Northumberland, and parts of Sunbury counties in east-central New Brunswick. However, to the south, the number of moths captured was even lower than the already low levels of 1986; many traps were negative. In Nova Scotia, only one trap was positive (in Cumberland County) suggesting a reduction in populations there as well. Populations were not high enough to cause visible defoliation.

Three years of trapping indicates an overall downward population trend, with low populations being maintained in those areas where jack pine is a naturally abundant species. Positive locations in New Brunswick in 1987 were 49%, compared with 60% in 1986 and 84% in 1985.

Mountain pine beetle

Dendroctonus ponderosae Hopk.

Lodgepole pine is the principal host of the mountain pine beetle, but several other western pine species are also susceptible. The beetles attack trees in mid- to late summer and infect them with several microorganisms, including blue stain fungi. Eggs laid by female beetles yield larvae that feed on the inner bark. Infested trees generally die from the combined action of blue stain fungi and the beetle larvae. The foliage

of killed trees usually turns red-brown in the year following attack and tree mortality can then be detected by aerial surveys.

Because most beetle-killed trees are of suitable size for saw logs, the monetary loss in commercial forests can be significant if trees are not salvaged quickly. Other consequences are a hastening of forest succession, a change in age and diameter distribution of the pine component of forests, a reduction in aesthetic values, and an increase in fire hazard. Each of these effects can force disruptive and costly changes in forest management plans. Many companies have shifted operations to concentrate on the salvage of recently killed trees, particularly in British Columbia where large volumes of dead trees are involved.

British Columbia

Mountain pine beetle continues to be the most harmful forest insect in British Columbia. Outbreaks have been recorded at varying geographic locations within British Columbia and Alberta at irregular intervals since at least 1910. The current series of outbreaks started during the late 1960s and early 1970s. The area of newly red trees (attacked the previous year and often called faders) increased each year until 1984, with very rapid increases in the early 1980s. Cumulatively, over 204 million mature pine have been killed, and harvesting plans throughout the province have been severely affected.

The area and volume of lodgepole pine and some white pine killed by mountain pine beetle in 1987 declined overall by about 30% to the lowest level in seven years. However, more than 8900 infestations are still active on more than 66 470 ha, from the international border south of Cranbrook to north of Terrace (Figure 4). This is almost double the area burned by forest fires in British Columbia in 1987 and represents about 10% of the annual lodgepole pine harvest. Also, lodgepole pine killed by the beetle before 1985 and which is now unsalvageable covers more than 1.86 million ha and 75 000 ha in the Cariboo and Kamloops regions, respectively.

Declines due to host depletion, including harvesting, occurred in the western part of Kamloops Region (down 60% to 19 000 ha) and in the Homathko River Valley in the Vancouver Region (down 65% to 1470 ha). Infestations declined 18% in the Nelson Region, but remained active over 23 100 ha mainly south of Cranbrook, near Invermere, and Grand Forks. The area of pine killed by the beetle increased in three regions. In the Cariboo Region, where in late 1984 and early 1985 most populations were killed by below-normal temperatures, a new infestation developed over 500 ha near Chilko Lake. In the Prince Rupert Region, the increase was 25% to 18 600 ha, and in the Prince George Region there was nearly a threefold increase to 4300 ha, mostly northwest of Fort St. James.

Overwintering brood mortality assessed in 52 major infestations in six forest regions in early 1987 was less than 10%. Regional R values, the ratio of overwintering progeny to parent beetles, ranged from 0 to 20; most populations were increasing. A mild 1986-87 winter and a hot, dry 1987 summer, along with increased populations, resulted in an increased number of new attacks in mature lodgepole pine. New attacks averaged 20% in 42 stands in five forest regions, up from 11% in 1986. Current attacks were higher in all regions; the highest were in the Prince George and Prince Rupert regions at 34% and 33%, respectively.

The area of mature pine killed by the beetle in 1987 in the Kamloops Region contained about 1.8 million trees (852 000 m^3). The decline, largely due to host depletion, occurred mainly around Lillooet, where most mature susceptible lodgepole pines have been killed since 1972 when the outbreak first developed. However, active infestations continue east of Kelowna and west of the Okanagan Valley. Groups of five to 10 beetle-killed pine near Merritt were less numerous this year and were often associated with a concentrated pheromone-baiting program by the British Columbia Forest Service. Pockets of recently killed pine were widely distributed southwest of Princeton and spot infestations remain southwest of Keremeos following host depletion and some harvesting.

Pine mortality in the Cariboo Region remained at the lowest levels since 1972, except for a new infestation over about 500 ha near Chilko Lake. Pine mortality is expected to remain generally at low levels throughout the region in 1988. Cruises in eight stands found 38% of the stems attacked by engraver beetles, *Ips* spp., but no new mountain pine beetle attacks. Tree mortality resulting from attacks in May and July was evident within 15 m of cutblock boundaries. Slash accumulation and hot dry weather, which prevented slash disposal were the major factors in increased engraver beetle populations.

Mountain pine beetle infestations in the Nelson Region including National Parks encompassed 1.2 million trees (440 000 m^3). Although infestations along the British Columbia-Alberta border continued to decline, those near Grand Forks, Cranbrook, Invermere, and in Kootenay National Park increased for the second consecutive year to 4367 infestations. Newly attacked trees also increased slightly to an average of 13% in 13 stands, indicating continued but varied amounts of tree mortality in 1988, with the highest at Redstreak Creek (64%) in Kootenay National Park and near Steamboat Mountain (25%) west of Invermere.

The area of lodgepole pine killed by the beetle in the Prince Rupert Region increased, for the second consecutive year, to 18 600 ha, which translated to 2.5 million trees (1.5 million m^3). This major increase occurred throughout previously infested areas, mainly the Kispiox, Hazelton, and Kitwanga areas. Increased tree mortality is again forecast; current attacks increased to 33% overall (range 11% to 68%).

Infestations expanded nearly threefold in the Prince George Region to 4300 ha (160 000 trees; 132 000 m^3), mostly northwest of Fort St. James. Current attacks northwest of Fort St. James averaged 34%, indicating continuing populations in 1988. Pine beetle control operations in Mt. Robson Provincial Park reduced the number of beetle-

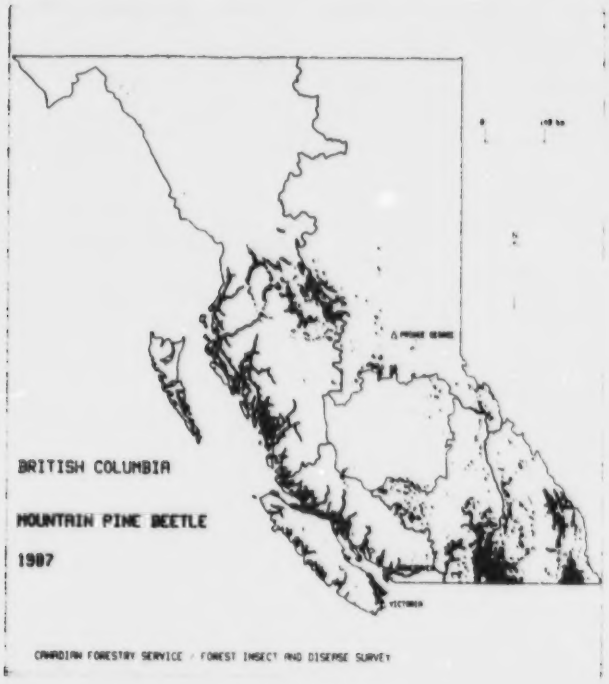

Figure 4: Mountain pine beetle mortality in British Columbia, 1987.

killed pine to 21 trees from 259 in 1985. The total area containing recently killed pine in the Vancouver Region declined to 1470 ha and 55 000 trees (39 000 m^3), and the number of infestations declined 43%. The decline, due to host depletion, was mostly in the Homathko River Valley and to a lesser extent east of Pemberton.

In the fourth year of a special protection program, the B.C. Forest Service allocated $9.6 million towards road construction to extract threatened timber, for cut and burn or MSMA treatments to reduce the spread of bark beetles, for aerial photography and ground surveys, and for pheromones for monitoring and aggregating beetle dispersal.

Alberta and Saskatchewan

Infestations of the mountain pine beetle remained at endemic levels in southwestern Alberta and Saskatchewan, and in the Rocky Mountain National Parks, except in the Kootenay and Yoho Parks in British Columbia. Estimated numbers of recently killed lodgepole pine are shown in Table 5 for the five Rocky Mountain National Parks.

An examination of 22 infested lodgepole pine at three locations in Kootenay National Park in early May indicated good survival of the overwintering larval population and some adults (about 3.7%). This suggested that populations were still expanding, and that a small but early flight of adult beetles could be expected. Parasitism, caused mostly by the fly, *Modetera aldrichii* Wheeler, resulted in 5-10% mortality of larvae.

Table 5. Numbers of lodgepole pine trees recently killed by the mountain pine beetle in the Rocky Mountain national parks surveyed in 1987

National Park	Estimated new tree mortality	
	1986	1987
Banff, Alberta	10	25
Kootenay, British Columbia	5500	3870
Yoho, British Columbia	130	105
Waterton Lakes, Alberta	55	220
Jasper, Alberta	0	0

In Banff National Park, all of the infested trees occurred near the south end of the park adjacent ot the Spray River. Examinations of broods in a few trees indicated low percentage egg hatch, low survival of larvae, and no evidence of live adults, probably due to the high elevation.

Mountain pine beetle infestations in Kootenay National Park occurred in about 150 patches of varying size, extending mainly between Daer and Pitt creeks and along the Kootenay River valley to the south end of the park. Several large patches occurred within 2-4 km of Radium and three new spot infestations were noted north of Highway 93 and east of Sinclair Pass.

In Yoho National Park, most infestation patches occurred in the same locations as last year and in groups of one to five trees. A slight expansion in numbers of dead trees occurred near Field in five patches containing 35 trees.

Nearly all of the newly killed pine in Waterton Lakes National Park occurred as single trees scattered on northern slopes of Chief Mountain and along Cameron Lake and Red Rock Canyon roads.

Elsewhere in the region, semiochemical lures were used as part of the detection survey and control strategy for the mountain pine beetle in the Cypress Hills, Kananaskis area and southern Bow-Crow Forest of Alberta. In the Saskatchewan portion of the Cypress Hills, 300 lures were distributed by Saskatchewan Parks, Recreation, and Culture staff, and only five fresh attacks on three baited trees were observed. A total of 37 new fader pine trees were mapped but none had been attacked by mountain pine beetle. In the Alberta portion of the Cypress Hills, where 200 lures were deployed by provincial park staff, 43 fresh attacks occurred on 20 baited trees; none of the attacks were successful. No new or recent beetle-killed trees were observed. About 90 recently killed trees observed from aerial surveys were believed caused mostly by porcupine feeding.

In southwestern Alberta, the Alberta Forest Service conducted two aerial surveys and deployed 150 semiochemical lures at 20 sites in the Kananaskis area and at 30 sites in the Crowsnest Pass area. Only a few recently killed lodgepole pine and limber pine were observed near Blairmore during the aerial survey. Of the 150 baited trees, 82 had fresh attacks and an additional 36 adjacent trees were attacked. Fifty of the attacked trees were in the Kananskis area. Of the 118 attacked trees in the two areas, 47 were cut and burned while the remainder were treated by removal of individual galleries. The infestations in 1987 were slightly higher than had been reported in 1986.

Spruce beetle

Dendroctonus rufipennis (Kby.)

The spruce beetle belongs to a genus of bark beetles that periodically cause significant mortality to the conifer forests of Canada. It infests all species of spruce in Canada, with white spruce and Sitka Spruce as the primary hosts. The annual mortality attributable to the spruce beetle is difficult to determine because much of the mortality, except for outbreaks, originates from single or small groups of trees scattered throughout the forests. Populations are normally endemic in forest debris and overmature timber. However, stand disturbances such as blowdown, cull, or right-of-way logging operations create breeding material which facilitates population buildup. Under outbreak conditions, attack can occur on pole-sized, immature timber, and on atypical hosts such as lodgepole pine when these are mixed with the primary hosts.

British Columbia

Overall, the area and volume of mature white and Engelmann spruce killed by the spruce beetle in British Columbia declined for the fifth consecutive year to 63 infestations over 3000 ha. Although active in all six forest regions, all but 80 ha of the recent beetle-killed stands were in higher elevation stands south of Gold Bridge and west of Princeton in the Kamloops Region. The decline has been due to salvaging of infested trees, improved sanitation, host depletion, and low temperatures in 1984 and 1985.

The only area of increase of recently killed mature spruce occurred over 2900 ha in the Kamloops Region in the Anderson Lake and Gold Bridge areas where 11 remote, high-elevation infestations covered 2050 ha, up from 1360 ha in 1986. West of Princeton, infestations increased slightly to 875 ha in 22 pockets.

In the Prince George Region populations were at endemic levels in scattered pockets over 17 ha, mostly in the McGregor and Bowron river drainages. Endemic levels also occurred in the Prince Rupert Region. However, pockets of 1986-attacked spruce in the upper Kispiox River drainage contained high numbers of broods. These broods will pose a threat to adjacent stands when they emerge in 1988. Current attacks are restricted to single trees, mostly in the northeastern part of the region and usually those predisposed by disease or windthrow. Twenty mature spruce, mostly windthrown, in pockets along the Haines Road north of the Alaska border were very lightly strip-attacked. Trees in the area have been predisposed to beetle attack by road construction since 1983. However, control programs have effectively reduced the potential for continuing tree mortality.

Little change is expected in the status of the beetle in 1988. Nevertheless, endemic populations in scattered windthrow, right-of-way logs, and butts of standing trees in most regions have the potential to threaten nearby susceptible mature stands.

Alberta

Populations of the spruce beetle remained low in all areas of the region in 1987. Light populations were detected in a mature spruce stand 50 km north of Manning. In the Grande Prairie Forest District in west central Alberta, spruce beetle surveys were conducted in Moonshine Lake Provincial Park, Two Lakes Recreation Area, and along the Kakwa River. Endemic populations causing occasional tree mortality occurred at the latter two sites.

Maritime Provinces

Spruce beetle remained active throughout the Region in 1987 and white spruce mortality occurred in all three provinces.

In New Brunswick, spruce beetle damage was reported in 1980 after a 50-year period of inactivity. Since then the insect has been found in a number of widely separated areas, mostly in the southeastern and northwestern parts of the Province.

In 1987, infestations remained active and caused further tree mortality. On Grand Manan Island almost half (48%) of the mature and semimature white spruce trees are either infested or dead in the North Head - Castalia and the Long Eddie Point areas. Infestation levels were about the same as in 1986 along the Shepody Road in Fundy National Park. Scattered mature and semimature white spruce trees are dead or dying a 10 ha area south of Lucky Lake near the Restigouche - Gloucester County line, possibly from spruce beetle attack.

In Nova Scotia, Cape Breton Island constituted the major outbreak area during the early part of the 1980s and, by the end of 1983, no large areas remained without severe white spruce mortality. Beetle activity decreased between 1984 and 1986 on Cape Breton Island but there was an increase in the number of spruce beetle-attacked white spruce on the mainland. In 1987, the level of insect activity was similar to that observed in 1986, with most of the tree mortality occurring on Cape Breton Island and on the northern mainland. Scattered pockets of affected trees were observed in parts of Lunenburg, Yarmouth, Digby, Annapolis, and Kings counties. The largest outbreak was recorded on the southwest shore of Big Mushamush Lake, Lunenburg County, where trees over a 10 ha area were affected. Damage in affected stands in 1987 ranged from 1% to 36% of the trees dead or dying.

In Prince Edward Island, the spruce beetle killed an estimated one-third of the merchantable white spruce by 1983 when infestations peaked. Beetle populations have decreased steadily since that time and in 1986 only a very few newly infested white spruce trees were observed in the Province. In 1987, there was an increase in infestation. Numerous newly attacked trees were observed in white spruce stands at Hermanville, St. Margarets, and Victoria Cross, Kings County, at scattered locations in Queens County, and at North Bedeque, Prince County. The highest level of damage was recorded in a semimature stand at Little Lands, Kings County, where 28% of the trees were dead.

Eastern larch beetle

Dendroctonus simplex Lec.

This insect normally attacks only weakened, damaged, or recently felled host material. However, when populations are very high, the insect can also attack living, apparently healthy, mature or overmature trees. Even younger, small diameter trees can become infested.

Maritime Provinces

A population buildup was first noticed in Nova Scotia in 1976. This increase in beetle population followed several years of severe defoliation of larch by the larch sawfly *Pristiphora erichsonii* (Htg.). Since then, the beetle has become widespread in all three provinces and has caused serious tree mortality. By the end of 1981, an estimated 24% of merchantable-size larch was dead in New Brunswick, 64% in Nova Scotia, and 13% in Prince Edward Island. Insect populations have been generally declining since 1984 and the number of trees succumbing to beetle attack has also decreased in most areas.

In 1987, newly attacked trees were observed in York, Carleton, Northumberland, Queens, and Sunbury counties in New Brunswick and at Muddy Creek, Prince County, Prince Edward Island, where 20% of the larch trees were infested. No eastern larch beetle infestations were observed in Nova Scotia.

At the central New Brunswick research plot, there was a further increase in newly infested trees as 7.6% of the trees were attacked in 1987, compared to 6.7% in 1986, 2.8% in 1985, 3.8% in 1984, and 2.9% in 1983. Cumulative larch mortality due to attack by the eastern larch beetle has increased to 42% in 1987, from 6% in 1979, when the plot was established, an average of 4.7% annual tree mortality.

Gypsy moth

Lymantria dispar (L.)

The gypsy moth has been the most destructive insect of hardwoods and, to a lesser degree, of conifers for decades in the northeastern seaboard. Female moths are flightless, limiting the spread of this pest to dispersal of the minute early instar larvae on air currents or to artificial transport as eggs or larvae on human conveyances.

Trapping male moths with pheromone traps has become a common practice throughout Canada. Trapping information is used to help detect the gypsy moth, define where local populations may be found, and to assist the search for other life stages.

Newfoundland

A survey to find a gypsy moth present on the Island was conducted by FIDS in cooperation with Agriculture Canada. Pheromone traps were placed in camping sites, parks, and near towns to catch moths that might be introduced by recreation vehicles from infested areas on the mainland. Only one male moth was trapped, in Pippy Park in St. John's.

Maritime Provinces

After its reappearance in the Maritimes in 1981, the gypsy moth gained further ground in 1987. It appears to be established in both New Brunswick and Nova Scotia and caused visible defoliation in the Region for the first time in nearly half a century.

The status of the outbreak in Maine has been of special concern because of its proximity to the Maritimes. In 1987, gypsy moth populations in Maine were low but they have increased over the past few years. There were 262 ha of forest defoliated by gypsy moth in the state of Maine in 1987.

In the Maritimes, the gypsy moth monitoring committee remained active in 1987, and again coordinated all surveys. This committee, formed in response to the discovery of gypsy moth in 1981, is an effort to utilize available manpower more efficiently. Organizations involved in surveys included the Forest Insect and Disease Survey of the Canadian Forestry Service, Parks Canada of the federal Department of Environment, the Plant Health and Inspection Branch of Agriculture Canada, New Brunswick Department of Natural Resources and Energy, New Brunswick Department of Agriculture, New Brunswick Department of Tourism, Recreation and Heritage, Nova Scotia Department of Lands and Forests, Nova Scotia Department of Agriculture, Prince Edward Island Department of Energy and Forestry, and numerous municipalities. Many volunteers, campground operators, small woodlot owners, Christmas tree growers, students, and other interested private citizens also assisted in the pheromone trapping program.

In 1987, early season egg-mass surveys, larval surveys, adult trapping programs, and late fall egg-mass surveys were conducted to determine the current status of the insect in the Region.

The adult male trapping program is aimed at defining areas where egg-mass searches should be concentrated. As a result of studies since 1980, the trap placement design was changed in 1983 to eliminate or at least to minimize interference from large numbers of male moths brought into the Region by weather fronts from infested areas in the United States. Information was obtained from 3565 traps; 1481 in New Brunswick, 1734 in Nova Scotia, and 350 in Prince Edward Island. Over 90% of the traps distributed were returned. This and better understanding by cooperators of the value of negative results greatly aided the planning of the fall egg-mass surveys.

The status of the gypsy moth in the Maritimes in 1987 was as follows:

In New Brunswick, the first visible defoliation since the reappearance of gypsy moth after an absence of almost half a century occurred near Moores Mills, Charlotte County. Severe defoliation of hardwoods in a patch of less than 5 ha resulted from feeding by gypsy moth. Larvae also fed on foliage of fir and spruce regeneration and on ground vegetation. The larval population was extremely high at this isolated location but aerial and ground surveys failed to detect any other areas of visible defoliation in the Province.

Many larvae were dead in early July, at about the time when pupation commenced, and counts made to obtain some indication of the health of this population showed that:

1. About one third of the late instar larvae were dead (32% of 1562 larvae counted in cooperation with the New Brunswick Dept. of Natural Resources and Energy);

2. Most of the larvae that died were killed by a virus disease (88%), a few by bacteria (8%), and some were parasitized (4%) -- based on a small sample of only 25 dead larvae identified by Forest Pest Management Institute, Canadian Forestry Service; and,

3. Almost one third (32%) of the gypsy moth that pupated did not develop to the adult stage, 12% having been killed by disease, 2% by parasites, and the rest from undetermined causes -- based on rearing of 41 pupae.

Gypsy moth egg masses and/or pupae were found during egg-mass surveys at 17 locations. With the addition of 12 new locations this year, the total number of areas where gypsy moth has been found at least once since 1981 is 44. However, only 8 of these areas are outside Charlotte County and, with the exception of Fredericton, the gypsy moth has been found only once at any of these locations. In Saint John, an unemerged pupa was found in 1981 and the lack of any activity in this area since then indicates the introduction of a larvae rather than an egg mass. A similar situation is suspected in the area near Peel, Carleton County, where two years of extensive trapping and searching have failed to confirm the presence of gypsy moth.

Over 80% of the known gypsy moth locations in New Brunswick are in Charlotte County and all 17 areas where gypsy moth was found in 1987 are in the western half of the county. In view of the above, the western half of Charlotte County of New Brunswick is considered to sustain a generally low level but widespread population of gypsy moth, both in the forest and, at least in the case of St. Andrews, in urban areas.

In Nova Scotia, gypsy moth was found at 11 locations in seven of the nine counties in the western half of the Province. All but one of the areas were either the same or adjacent to areas where the insect had been found in previous years. The exception was Canning, Kings County, which represents a minor extension in distribution. Egg masses were not numerous in most areas except at New Minas and Annapolis Royal but, even there, noticeable defoliation did not occur in 1987. It is worth noting that, in spite of extensive searching, gypsy moth was not found in several areas, most notably Yarmouth County, where egg masses were present in previous years.

The gypsy moth has not occurred in Prince Edward Island to date. There was only one male moth caught in one of

over 300 pheromone traps in the Province, at Montague, in the eastern part of the Island.

In New Brunswick most of the gypsy moth locations are in forested areas, away from habitation, and are concentrated in a small section of the Province adjacent to an area of the United States where the insect is known to be present. In Nova Scotia almost all of the infested spots are inhabited areas with considerable movement of people. This suggests that, while in New Brunswick the presence of gypsy moth may generally be the result of natural spread, in Nova Scotia the insect was likely imported by commercial traffic, visitors, or residents travelling in gypsy moth-infested areas.

Control operations against the gypsy moth in 1987 included:

Moores Mills, N.B. - A cooperative effort to eradicate or at least reduce the population at this isolated high intensity outbreak was complicated by the fact that, at the time of its discovery, pupation was already in progress and some moth emergence had already occurred. An area of 3.7 ha was root-raked and the brush piled; the area was ground sprayed with a water mixture of Permethrin (Ambush 500 ECR) at a rate of 35 g/ha; a trap-out pheromone program was conducted, involving over 350 non-saturating and 150 delta traps; about 380 egg masses were removed during a concentrated survey; the brush piles were burned in the fall after the egg laying period had been completed.

Fredericton, N.B. - A trap-out program in a small area of the city was repeated for the second year. In 1987, a total of only nine gypsy moth male adults were captured in the 572 traps returned (of 580 placed), and preliminary surveys failed to locate any fresh egg masses.

Shelburne, N.S. - About 500 male adults were captured in 388 traps (of 489 placed), during a trap-out program. The number of moths caught is about the same as captured in the town in 1986. At least 15 fresh egg masses were also found in Shelburne.

Other - More and more communities are becoming involved in public awareness programs emphasizing citizen participation in combating this newly arrived pest.

Québec

This year there was a respite in the steady advances made by the gypsy moth in the area north of the Ottawa River since 1985. In 1986, several pockets of moderate-to-severe defoliation were visible between Montebello and Eardley, near Gatineau Park, affecting some 4670 ha of forest land to varying degrees.

In 1987, although the gypsy moth occurred throughout this area, it caused little damage except between Hull and Eardley where over 1500 ha were defoliated. Red oaks, white oaks, trembling aspens, and white birches on the Eardley escarpment, which forms the southern boundary of Gatineau Park, suffered severe defoliation of up to 100% in some areas. An aerial survey of damage revealed that over 830 ha of forest land between Eardley and Luskville were seriously affected, 350 ha exhibited signs of moderate damage, and another 350 ha, light damage.

Elsewhere in the province the infestation subsided, at times dramatically. In 1986, for instance, trees on 10 ha of land on Rigaud Mountain were completely defoliated. In 1987, not a single larva could be found at that location. Northwest of Joliette, near Sainte-Marcelline-de-Kildare, the trees on two small patches covering a total of 50 ha were severely defoliated in 1986, whereas this year there was barely any trace of defoliation. These two examples fairly accurately reflected the gypsy moth situation along the St. Lawrence River between Trois-Rivières and Huntingdon where the insect was present everywhere but caused very little damage (1% to 5% defoliation).

The Laurentian Forestry Centre, Canadian Forestry Service, in cooperation with the Plant Protection Division of Agriculture Canada, continued its survey of male gypsy moths between Mont Saint-Bruno and Québec City. The areas selected for monitoring lie between Saint-Antoine-de-Tilly and Inverness, Victoriaville and Lotbinière, and also include the Drummondville region.

The average catch for 1987 was 14.7 male moths/trap, down 19.7% from the 18.3 value recorded in 1986.

An egg-mass count was carried out in five sites located north and west of Hull. The selected stands suffered moderate-to-severe defoliation in 1987. On the basis of these findings, there should be less damage in 1988 than observed this year.

Ontario

Defoliation - In 1987, a reduction of over 90% was recorded in the area of moderate-to-severe defoliation, from 167 776 ha in 1966 to 12 678 ha in 1987 (Figure 5). Most of the decrease occurred in the central parts of the Tweed and Napanee districts which are the older infested areas. Defoliation in 1987 consisted of scattered pockets stretching from the western Carleton Place and Tweed districts through the Tweed and Napanee districts to the southwestern Lindsay District. Despite sharp population declines in the older infested areas, larvae were increasingly plentiful in the Lindsay and southern Minden districts. Larvae were also found in two previously uninfested areas in the Pembroke District and at several locations in Huronia and Maple districts. Light infestations occurred in several woodlots in Niagara District and a medium-to-heavy infestation occurred in South Walsingham Township, Simcoe District.

Burlap and Pheromone Trapping - For the fifth consecutive year, a burlap larval trapping program was carried out in provincial parks in southern Ontario by the FIDS Unit and the OMNR Parks Branch. This year, in order to build up data based on larval numbers in infestations of varying intensity, larval counts were made at specific dates and times at certain locations. The number of larvae captured at these sites

ranged from 0 to 2135 and averaged 210.5. The significance of these numbers should become more evident as a data base is built up over a number of years. Of more immediate significance were larval captures made at previously uninfested parks. These were as follows: Carson Lake Provincial Park and the Petawawa National Forestry Institute, Pembroke District; Balsam Lake Provincial Park, Lindsay District and Awenda, Bass Lake, and Springwater Parks, Huronia District.

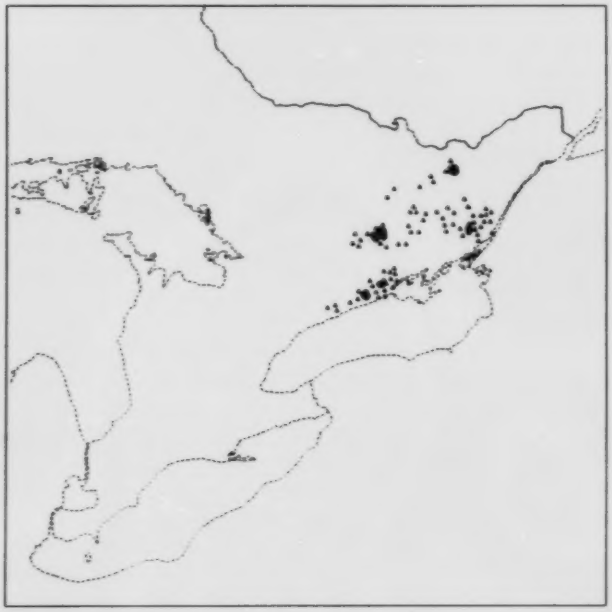

Figure 5: Occurrence of gypsy moth in Ontario, 1987.

As usual, an adult pheromone trapping program was carried out in most parks in southern Ontario, where burlap trapping took place, as well as in a few other locations. Moths were caught at all locations (65) where one or more traps were recovered, with the average number caught increasing marginally from 15.3 to 15.7 moths per trap. In the Eastern Region, where substantial declines in infestation occurred, the average number of moths captured was also sharply reduced from 32.2 in 1986 to 16.2 in 1987. However, in Algonquin Park and the Owen Sound District increases were recorded with the average moth catch increasing from 5.3 to 12.7 and 4.7 to 12.1 moths/trap, respectively. Substantial numbers of moths were also captured at Canadian Forces Bases Petawawa and Borden, and at the Meaford Tank Range where there is a high potential for spread due to the movement of personnel and equipment to and from other parts of the country.

A similar pheromone trapping program in northern Ontario yielded increased moth captures at a number of locations in the Sudbury, Espanola, and North Bay districts. Perhaps the most significant increase occurred at Killarney Provincial Park, Sudbury District, where the number of male moths caught increased from 1.6 to 21 moths per trap. Elsewhere in northern Ontario single moths were caught at the following parks: Fushimi Provincial Park, Hearst District; Kettle Lakes Provincial Park, Timmins District; Mississagi Provincial Park, Blind River District; and Rushing River Provincial park, Kenora District.

Control - In 1987, OMNR aerially sprayed some 40 249 ha of susceptible deciduous forest in eastern Ontario to prevent gypsy moth defoliation. The program involved both private and crown land and utilized three formulations of B.t. - Dipel® 132, Thuricide® 48LV, and Futura® XLV. Fixed-wing aircraft and helicopters were used to treat spray blocks with at least two applications five to 10 days apart, with some blocks receiving a third application.

The results of the program were difficult to assess due to the overall decline in gypsy moth populations. However, average defoliation rates were somewhat lower in sprayed areas and a 28% difference in the change in egg-mass densities was recorded in sprayed areas.

Forecast - Canadian Forestry Service crews carried out an egg-mass survey in sprayed and unsprayed plots to determine the efficacy of the 1987 spray program. Overall results indicate a decline of about 58% in egg-mass densities, indicating that a further decline in the area of moderate-to-severe defoliation can be expected in 1988. Small scattered pockets of defoliation will probably persist in a few areas in the central and western Tweed District. This fact notwithstanding, varying numbers of egg masses were discovered in a number of scattered areas in the Lindsay, Minden, Parry Sound, Huronia, Simcoe, Chatham, Maple, and Pembroke districts.

British Columbia

About 8244 pheromone-baited sticky traps were monitored throughout British Columbia in the thirteenth year of the cooperative program with Agriculture Canada (Plant Health), the British Columbia Forest Service, and FIDS.

In total, 221 adult male gypsy moths were captured in 56 traps in six areas compared with 24 moths in 19 traps in 1986. Males were caught for the second consecutive year at Kelowna (194, up from 7 in 1986) and near Canadian Forces Base Esquimalt (5, up from 3 in 1986). New catches were made at Qualicum Beach (1) and Parksville (12) on Vancouver Island and near Tsawwassen (3) south of Vancouver. New egg masses were found at Kelowna (30), Belmont Park (78), and Parksville (3), where 29 old egg masses were also found.

No adults were found in 282 traps set by the Forest Insect and Disease Survey in 233 forested recreation areas in national and provincial parks, commercial campgrounds, near military bases, and north coastal ports.

Intensified monitoring and periodic control programs have prevented establishment of gypsy moth populations in British Columbia and defoliation has not been observed. Following three years of positive trapping and four applications of *Bacillus thuringiensis* in 1987, no adults were captured at

Chilliwack. Potential quarantine restrictions and costly control programs remain the major concerns of the forestry sector should populations become established.

Male adult trapping and, when necessary, egg-mass surveys will continue in 1988 in cooperation with other agencies.

Forest tent caterpillar

Malacosoma disstria Hbn.

The forest tent caterpillar again caused moderate-to-severe defoliation on trembling aspen, as well as a variety of other hosts in many areas of Canada (Figure 6). Although outbreaks of this insect can look spectacular, there have been few reports of appreciable tree mortality. The main effect of outbreaks has been the reduction in annual growth of severely defoliated trees. The significance of this reduction is difficult to assess. The affected tree species comprise a major portion of the hardwood volume in Canada, yet a relatively small portion of it is harvested each year. As the utilization and management of aspen intensify, the impact of aspen defoliators will become more significant.

Newfoundland

Pheromone traps were placed across the Island in camping areas and near towns to collect moths that might be introduced on recreation vehicles from mainland Canada. Only male moths have been caught in these traps.

Maritime Provinces

Populations were very low throughout the Maritime Provinces and are expected to remain so in 1988 as indicated by light trap catches and pheromone surveys. Damage to trembling aspen, resulting from the recent outbreak, was widespread. The only population of note was present in the Granton area, Pictou County, Nova Scotia.

Québec

The forest tent caterpillar infestation, which has assumed epidemic proportions in the Abitibi - Témiscamingue area over the past three years, clearly lost much of its intensity this year. Natural control factors, such as parasitism and viral disease, seem to be well established and have succeeded in regulating tent caterpillar populations. Laboratory analyses of a sampling of 500 chrysalids from five locations (lakes Brodeur, Rollet, Angliers, Laverlochère, and Notre-Dame-du-Nord), where the epidemic has persisted since 1984, have shown a 90% rate of parasitism, compared to 74% last year. The fly *Sarcophaga aldrichi* Park was found to be the principal parasite. Also, in more recently infested areas, high levels of parasitism were clearly in evidence. South of Lake Kipawa, 400 tent caterpillar chrysalids collected over a 90-km stretch exhibited an estimated 75% rate of parasitic infection.

Defoliation - Despite the decline, forest tent caterpillars still caused serious defoliation of nearly 120 000 ha of hardwood forests. In 1986, 391 000 ha were severely damaged. Light and moderate defoliation, on the other hand, increased three- and four-fold, respectively, affecting 346 700 ha and 441 700 ha of forest land. This year the infestation occurred within the triangle formed by lakes Opasatica to the north, Dumoine to the east, and the two lakes of Mattawa to the south.

A closer examination revealed the existence of three vast, severely defoliated regions south of Rouyn between the localities of Montbeillard and Rollet (175 km^2), south of Belleterre (125 km^2, and, further south, not far from Lake Kikwissi (425 km^2). Severe defoliation was also observed in several smaller patches scattered throughout the infestation zone.

The 441 700 ha classified as moderately defoliated were found mainly in the center of the infestation area, between lakes Des Quinze to the north, Ogascane to the east, and Kipawa to the southwest. Virtually this entire area suffered severe defoliation in 1986. The 346 700 ha of lightly defoliated forest land, on the other hand, were on the fringe of the infestation area, extending the epidemic to the east and south of the 1986 site of infestation.

The insect attacked mainly trembling aspens although sugar maples also suffered seriously. A sugar maple stand not far from Témiscaming sustained 75% defoliation. Elsewhere in the province, 50 ha of trembling aspens were moderately defoliated near Bristol-les-Mines and Quyon. Further east, the forest tent caterpillar caused some light damage near Sainte-Adèle, Saint-Jérôme, and Saint-Côme.

Forecast - The presence of natural control agents observed last summer, coupled with an egg-mass survey conducted this fall, suggests that the infestation will continue to abate next year. Forest tent caterpillar will still be significant pest, however, in newly affected sectors.

Ontario

Defoliation - In 1987, infestations of this insect expanded for the third consecutive year with 1 649 977 ha of moderate-to-severe defoliation, up from 433 000 ha in 1986. Most of the defoliation occurred in the Northeastern and Algonquin regions in two large infestations. The largest of these was located along the Ontario-Québec border, in the North Bay and Temagami district of the Northeastern Region stretching into the southeast corner of the Kirkland Lake District of the Northern Region. The second pocket was located east of Georgian Bay in the Parry Sound and Bracebridge districts of the Algonquin Region, with a small extension in the Huronia District of the Central Region. Numerous small pockets of moderate-to-severe defoliation were mapped from the city of Sault Ste. Marie eastward through the Sault Ste. Marie, Blind River, Espanola, Sudbury, and western North Bay districts. Similarly, numerous small pockets were also recorded in the Parry Sound, Minden, and Bracebridge districts of the Algonquin Region along with a few, small in-

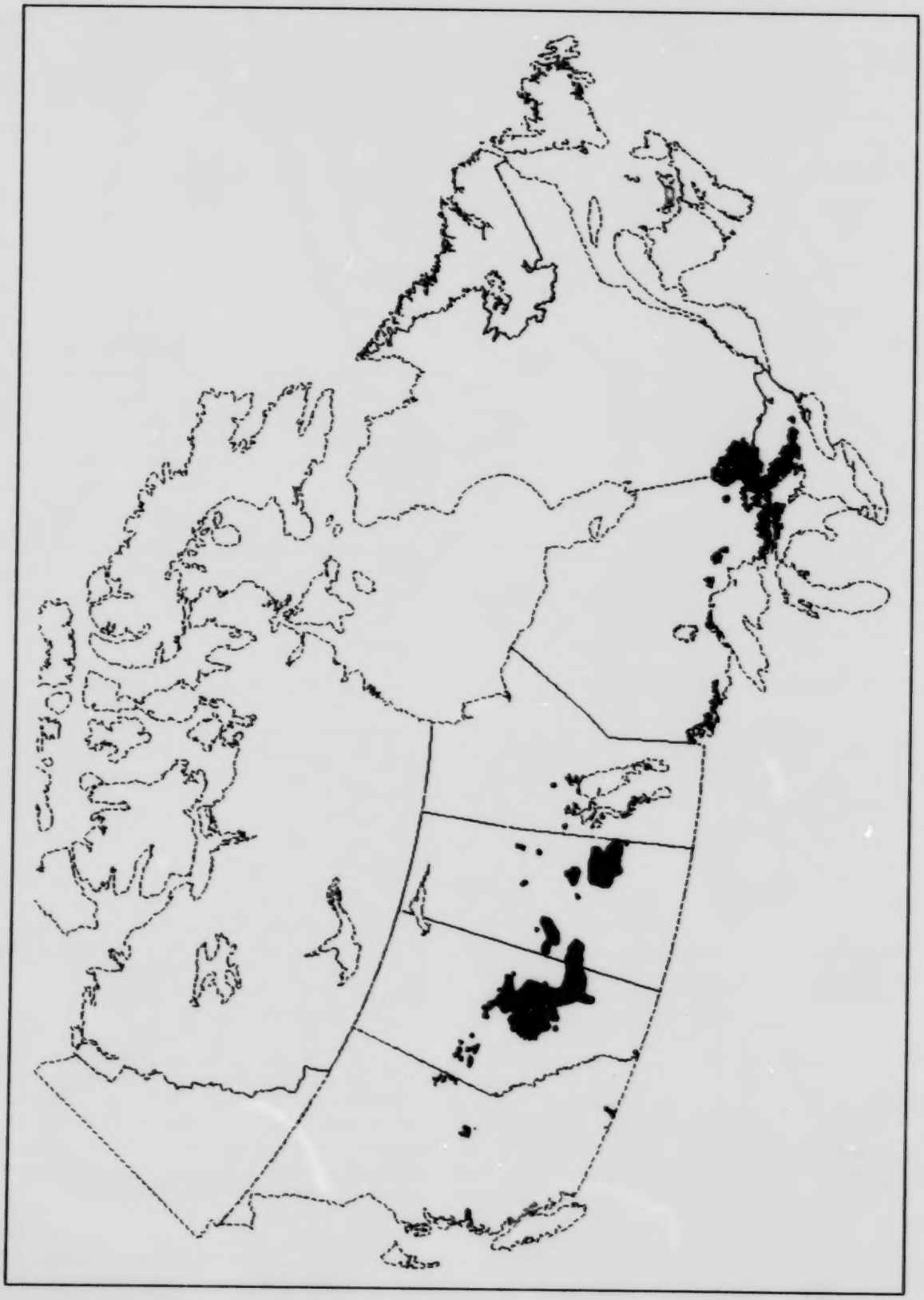

Figure 6. Forest tent caterpillar occurence in Canada, 1987.

festations in the Tweed and Carleton Place districts of the Eastern Region. Elsewhere in northern Ontario, scattered pockets of infestation were mapped in the Kirkland Lake and Chapleau districts of the Northern Region, the Wawa district of the Northeastern Region, the Terrace Bay and Thunder Bay districts of the North Central Region, and the Fort Frances District of the Northwestern Region.

Forecast - Egg-band counts carried out in the fall of 1987 indicate that infestations will remain heavy in most of the areas described in the Northeastern and Algonquin regions. In addition, many of the smaller pockets may coalesce to form larger blocks of moderate-to-severe defoliation.

In contrast, infestations in the southwest Kirkland Lake District that have persisted longer than most of the other areas described may begin to decline in 1988. Infestations in the Huronia, Tweed, and Carleton Place districts are expected to remain high and possibly expand in size. Populations in the Wawa District and adjacent areas of Terrace Bay District will probably persist at about the same level, but two small pockets in the southern Thunder Bay District will probably decline or disappear next summer. Infestations in the western Atikokan District and adjacent Fort Frances District may expand and many of these smaller pockets may coalesce to form much larger infestations in 1988.

Prairie Provinces

The composite land area within which trembling aspen stands were defoliated in 1987, primarily by the forest tent caterpillar, amounted to an estimated 7 865 103 ha in the three prairie provinces. This represents an almost 60% increase over 1986. Most of the increase occurred in Alberta; a decrease of 74% was noted in Manitoba. Because a large portion (about 80%) of the outbreak occurred within the agricultural zone, where aspen stands are often small and dispersed, the estimated areas of defoliated stands are given in Table 6. The large aspen tortrix *Choristoneura conflictana* (Walokee) caused significant defoliation in several forested areas in central Saskatchewan.

Table 6. Summary of moderate-to-severe defoliation caused by the forest tent caterpillar in the Prairie Provinces in 1987

Province	Areas mapped (ha)	Estimated areas of aspen defoliation (ha)
Manitoba	4403	4403
Saskatchewan	1 250 000	250 000[a]
Alberta	6 610 700	1 322 140[a]
Total	7 865 103	1 576 543

[a]Estimated as 20% of the total area mapped.

In Manitoba, moderate-to-severe defoliation of aspen stands by the forest tent caterpillar was reported at two locations; near Rocky Lake (3108 ha) in the Saskatchewan River Forest Section and near Wabowden (1295 ha) in the Nelson River Forest Section. This was the third consecutive year of decline. No egg-band surveys were undertaken in the province to predict population changes for 1988.

The early aspen leafcurler *Pseudexentera oregonana* Wlshm. caused noticeable feeding damage of aspen throughout Manitoba and caused moderate-to-severe foliage damage near Pine Falls, Lake Francis, Gypsumville, and in the Spruce Woods Provincial Forest. Low populations of the large aspen tortrix were present near Lake Francis, Gypsumville, and in Duck Mountain Provincial Park.

In Saskatchewan, the total composite land area of aspen and other associated broadleaf trees defoliated was estimated at 1 250 000 ha, a slight decrease over that reported in 1986. However, while a larger portion of defoliated aspen stands occurred within the agricultural zone in 1986 there were increased extensions into the forested areas in 1987, thus increasing the actual area of defoliated aspen from 177 160 ha in 1986 to about 250 000 ha in 1987. Moderate-to-severe defoliation occurred in 11 infestation areas caused mostly by the forest tent caterpillar throughout the agricultural zone. In the forested zone of pure aspen and mixedwood the large aspen tortrix was a common and important contributor to defoliated stands, and was the main defoliator between Reserve Lake and Lady Lake in the Porcupine Provincial Forest and north of Macdowall in the Nisbet Provincial Forest.

Four infestations were mapped in western Saskatchewan, three in the Meadow Lake area, and one between North Battleford and the Alberta border. The largest infestation occurred in eastern Saskatchewan, extending between Melfort and Big Quill Lake eastward almost to the Manitoba border. Three infestations, one near Lac La Range and the others between Lac La Range and the Manitoba border, were observed only during aerial surveys and, therefore, the defoliator species are uncertain.

Egg-band surveys conducted in late 1987 at 73 locations throughout the outbreak area suggest the forest tent caterpillar will again cause significant defoliation in 1988. Moderate and severe defoliation levels can be expected in at least 50% of the locations sampled, and that same increase will occur in total area defoliated.

In Alberta, the total composite land area of aspen stands moderately to severely defoliated increased 34% to 6 610 700 ha in 1987. As in Saskatchewan, most of the defoliated stands (about 80%) were distributed throughout the agricultural zone, although infestations in 1987 expanded in five forest districts including Slave Lake, Peace River, Grand Prairie, Edson, and Whitecourt. In all areas of the outbreak, the forest tent caterpillar appeared to be the dominant defoliator species. The main area of outbreak extended broadly from Lesser Slave Lake southeastward through Edmonton to the Saskatchewan border and northwestward into

the Peace River and Grande Prairie districts. Two isulated patches of defoliation occurred, one in the eastern part of Waterton Lakes National Park and the other in the Buffalo Head Hills in northern Alberta.

Above average temperatures during much of April and early May allowed early development of aspen foliage and tent caterpillar egg hatch, commencing in late April. Young larvae were observed feeding during the first week of May throughout much of the outbreak area in Saskatchewan and Alberta. However, a late spring snowfall on May 18 and 19, centered in central and east-central Alberta, and freezing temperatures mostly between -5°C and -9°C on May 20-21, caused top-kill of some aspen clones and variable amounts of larval mortality. The larvae were in the fourth and fifth instars at the time of the storm. Patches of top-kill aspen extended throughout central Alberta and into west-central Saskatchewan.

Egg-band surveys to predict 1988 defoliation levels were conducted at several locations. Moderate and severe defoliation levels are expected in central and western Alberta, and light and moderate levels in eastern Alberta.

British Columbia

Defoliation of deciduous trees and shrubs by increased populations of forest tent caterpillar *Malacosoma disstria* Hbn. was more severe and widespread in parts of the Nelson and Prince George regions than in 1986. Defoliation increased near Kamloops but declined in the Peace River area. Western tent caterpillar *M. californicum pluviale* (Dyar) populations in southwestern British Columbia declined due to increased viral infection. This resulted in less severe defoliation of mixed deciduous stands, including alder, than in 1986. Populations in the Okanagan Valley increased for the second consecutive year, and were recorded near Bella Coola for the first time.

Forest tent caterpillar populations around Prince George increased significantly and defoliated trembling aspen in 70 separate infestations over 8300 ha, up from 580 ha in 1986. Defoliation, mainly west and northwest of Prince George, was light in 26% of the area, moderate in 43%, and severe in the remainder. Declining populations in the Peace River area caused light-to-moderate defoliation of about 55 aspen and cottonwood stands over 8650 ha, down from 91 700 ha in 1986. The decline in the fifth year of infestation in some areas was mainly west of Fort St. John and south to Tupper, and between the Kiskatinaw River and Groundbirch. Cold, wet weather during larval activity may have contributed to the decline.

In the Nelson Region, trembling aspen, cottonwood, and birch in about 120 separate stands over 7 250 ha were moderately or severely defoliated by the forest tent caterpillar. This was mostly near Trail, Rossland, Castlegar, and Slocan. It was a sixfold increase from 1986 and the fourth consecutive year of defoliation in some areas. Numerous small pockets of mixed deciduous stands from Creston to Golden were lightly defoliated, and several cottonwood stands totalling 200 ha near Kitchener, Fort Steele, Wardner, and Galloway were severely defoliated for the first time in 10 years.

Increased forest tent caterpillar populations in the Kamloops Region severely defoliated poplar, willow, maple, and birch over about 5 ha at the south end of Monte Lake and south of Falkland. In the North Thompson River Valley, where the last infestation in the region occurred in 1979, willow and maple in a 20 ha area south of Barriere were severely defoliated.

Egg-mass samples from five recently infested stands in the Prince George Region, including the Peace River area, indicate continuing populations and variable intensities of defoliation in 1988. Defoliation is also forecast to continue in the Nelson Region between Rossland and Slocan, and near Fort Steele.

Western tent caterpillar colonies in southwestern British Columbia were initially numerous and widespread, in some areas for the seventh consecutive year. In most areas, however, up to 50% of the larvae were infected and killed by nuclear polyhedrosis virus before they matured. This resulted in significantly less defoliation throughout the Fraser Valley, the Sunshine Coast, the Gulf Islands, and in east coastal areas on Vancouver Island than was expected, considering the high numbers of young larvae and numerous colonies earlier in the year.

Over 100 ha of alder and white birch near Hagensborg and near Belarko in the Bella Coola area were lightly to severely defoliated by western tent caterpillar. This is the first record of this defoliator in the mid-coastal area of British Columbia.

Colonies of western tent caterpillar were also more common and widespread in the Okanagan Valley than in 1986. Defoliation of small pockets of alder, birch, and other deciduous trees and shrubs ranged from light-to-moderate from Vernon east to Lumby and south to Kelowna. Near Penticton, mixed deciduous stands covering up to 10 ha were lightly to moderately defoliated.

Newly developing infestations in the Bella Coola and Okanagan valleys are expected to continue in 1988, but virus-infected populations in southwestern British Columbia should decline further.

Hemlock looper

Lambdina fiscellaria fiscellaria (Gn.)

The hemlock looper is native to Canada and occurs from Newfoundland to Alberta, mainly on balsam fir. During an outbreak, however, it will feed on many conifers and even some hardwoods. Although all eastern provinces have periodic outbreaks, Newfoundland has had regular epidemics lasting from three to six years and occurring every 10-15 years.

Newfoundland

Defoliation - Surveys conducted in early summer showed moderate-to-high numbers of looper larvae along the west coast of the Island. The reddish discoloration of severe defoliation was less evident in the older parts of the outbreak (south of Corner Brook) because the surviving trees damaged last year produced less foliage this year. However, very severe reddening was evident elsewhere, because the high larval population, especially north of Bonne Bay, completely defoliated trees, leaving no fir foliage for late developing larvae. Larvae were observed feeding on black spruce, birch, alder, maple, and any herbaceous vegetation. Many of the late developing larvae died of starvation. A few isolated infestations with moderate-to-high larval numbers remained in central and eastern Newfoundland.

The aerial survey showed that the area of defoliation covered about 160 000 ha, including 150 000 ha in the moderate and severe category (Figure 7). Stands that were severely defoliated over the past two years in the headwater areas of the major rivers of southwestern Newfoundland are mostly dead or dying.

Control - The provincial Department of Forest Resources and Lands conducted an operational control program against the looper and treated about 165 000 ha with fenitrothion and about 4000 ha with *Bacillus thuringiensis*.

The Canadian Forestry Service, in cooperation with the Newfoundland Department of Forest Resources and Lands, conducted an experimental program testing the effectiveness of new formulations and dosages of fenitrothion, B.t., and diflubenzuron. Results of these experiments were good for fenitrothion and B.t. and only fair for diflubenzuron to reduce population levels of the hemlock looper.

In 1987 hemlock looper samples were collected from 22 locations in Newfoundland for biological mortality studies. The majority of larval and pupal parasites were the tachinid flies *Winthemia occidentis* and *Madremyia saundersii*. Several specimens of parasitic wasps were also recovered. The incidence of pathogenic fungus was greater in larval than pupal samples. *Paecilomyces farinosus* was the major fungus disease. *Entomophaga aulicae*, *Ergnia radicans*, and *Verticillium lecanii* also occurred. Parasitism and fungal disease in late instar larvae averaged 7% and 25%, respectively, in the older part of the infestation and only 1% in the

Figure 7: Areas of moderate-to-severe defoliation by the hemlock looper in Newfoundland, 1987.

youngest part. Pupal parasitism was 5%, and less than 1% of the larvae and pupae were infected by an unidentified microsporidian. In addition to the above, about 5% of the larvae were infected in the older and younger infestations, respectively, by a fungus tentatively identified as *Aureobasidium pullulans*. This fungus was less common in pupae and its pathogenicity is being investigated.

Damage - The majority of the severe defoliation occurred in western Newfoundland in predominantly mature and overmature balsam fir stands, but some semi-mature stands were also severely damaged. Tree mortality ranging from 50% to over 90% is already evident in areas severely defoliated in 1986 and similarly high levels of tree mortality are expected in stands defoliated in 1987. The Department of Forest Resources and Lands will assess damage at the inventory level.

Forecast - The egg survey commenced in mid-October and branches were collected from about 520 sample points throughout the Island. Based on a comprehensive analysis of all data available about the hemlock looper outbreak, including results of the egg survey, and assuming favorable weather during larval development, the total area of moderate and severe defoliation forecast for 1988 is about 118 000 ha distributed mostly in western Newfoundland. Moderate and severe defoliation is expected to occur along Broom Brook near Cape Anguills, from Codroy Pond to Highlands, on the Port au Port Peninsula, from George's Lake to Corner Brook, along the west coast to the Northern Peninsula from Goose Arm to Western Brook Pond, from Parson's Pond to Port au Choix, near Leg Pond in the Castor River Valley, and in a small area near Round Pond. Moderate-to-severe defoliation is also expected to occur in a few small isolated areas on the Avalon Peninsula.

Light defoliation is forecast to occur on about 48 000 ha mostly in western Newfoundland. In summary, the forecast indicates a decrease in the area of moderate and severe defoliation from 150 000 ha in 1987 to about 118 000 ha in 1988. It appears the outbreak is collapsing south of Bonne Bay except for the severe infestations near Corner Brook, on the Port au Port Peninsula, and near Codroy Pond. However, the egg density continued to remain high in most of the infestations north of Bonne Bay including most of Gros Morne National Park and in the Hawkes Bay area on the Northern Peninsula. In addition, the outbreak is expected to expand into the Castor River Valley, where moderate-to-severe defoliation is forecast to occur in 1988 in valuable mature balsam fir stands.

Maritime Provinces

In the Maritimes, populations have been generally low in the past few years. The last serious outbreak occurred in central Prince Edward Island in 1977 and 1978, when the insect killed 80% of the merchantable balsam fir and over 90% of the hemlock in the affected area. A small, persistent outbreak has existed in Nova Scotia since 1985.

In 1987, the hemlock looper continued to cause defoliation in the Diligent River-Yorke Settlement area of Cumberland County in Nova Scotia. Moderate-to-severe defoliation of balsam fir and light-to-moderate defoliation of red spruce occurred on about 20 ha. Great numbers of moths were observed in this area in the fall, indicating a continuation of the infestation in 1988. In other areas, larvae and moths were much more common than in previous years, an indication of a general population increase.

In Prince Edward Island, populations were generally low and no defoliation was observed. However, a moth flight was observed in the Wellington area of Prince County in the fall and the highest catches of moths since the mid 1970s were recorded in all three light traps in the Province. This and the increase from last year's numbers -- 319 from 11 in Prince County, 353 from 134 in Queens County, and 174 from 0 in Kings County -- indicate that hemlock looper may cause defoliation in some areas of the Province in 1988.

In New Brunswick, no defoliation occurred but larvae were collected at 11 locations in the southern part of the Province, the highest being 51 larvae in a collection from white spruce at Bloomfield Station, Kings County and 32 larvae from balsam fir at Drisdelle, Northumberland County.

Dutch elm disease

Ceratocystis ulmi (Buis.) C. Moreau

Dutch elm disease is caused by the fungus *Ceratocystis ulmi*, which is transmitted chiefly by elm bark beetles. It was accidentally introduced into Canada and, since its discovery in Quebec, has spread over an area stretching from southern Manitoba to the Atlantic Ocean, excluding Newfoundland. All native species of elm are susceptible, including white, red, and rock elms. The disease has caused extensive mortality in eastern North America and will probably become a serious problem in all areas where elms are grown. Few, if any, pests have had as great an impact on shade tree populations in urban areas as has Dutch elm disease. Elms are also valuable timber producing species in some areas and there the disease has had an important effect on the local economy.

Maritime Provinces

Dutch elm disease, was a major concern in all three Maritime provinces in 1987.

In New Brunswick, the disease is present wherever elm trees are found. The resurgence of infection reported in 1984 continued, especially along river valleys. Numerous infected and dying trees, both residual old trees and young saplings, were observed throughout the Province in 1987. The disease was found in two new areas for the first time in 1987. One tree was infected at Richibucto, Kent County within the already established range of the disease and about 50 diseased trees were discovered at Murray Settlement, Northumberland County in a 5 ha area. This latter location represents a minor extension in distribution.

In Nova Scotia, the intensification of the disease, evidenced by great numbers of dead and dying elm trees, continued within outbreak areas where no sanitation is practiced. There were only minor extensions in the known range of the disease in 1987 with its discovery at Windermere, Kings County and at Melford, Inverness County.

In Prince Edward Island, a major change occurred in the status of Dutch elm disease in 1987. The disease was first discovered in 1979 in a small area of northcentral Prince County. The initial discovery was followed by an immediate and vigorous sanitation cut by the provincial government. No infected trees were found in 1980 and 1981, one infected tree was identified and removed in 1982, there were none found in 1983 and 1984, one tree was found in 1985, and two trees in 1986.

In 1987, infected trees were found at Northam (1 tree) and at Tyne Valley (1 tree) where the disease has occurred previously. In addition, infected trees were found for the first time in Alberton (1 tree), Victoria West (3 trees), Richmond (1 tree), St. Hubert (1 tree), Mount Pleasant (2 trees at the junction of Enmore Road, 1 tree on the airport detour) and at Mount Royal, where 10 dead and 25 infected trees were found. Although at present the incidence of infection is generally low, scrupulous surveillance, increased public awareness, removal of infected material, and removal of beetle breeding material in communities where elm is of value as a shade tree is advised.

In Fredericton the progress of Dutch elm disease and the effects of the control program have been monitored since 1961 when the disease as first found in the city. The 31 trees killed by the disease in 1987 represented 1% of the current elm population within the Dutch Elm Disease Management Area. This loss is well in line with the reduction in the loss rate since 1980 when it peaked at 7.8%, followed by 5.3% in 1981, 3.0% in 1982, 2.4% in 1983, 1.1% in 1984, 1.2% in 1985, and 0.8% in 1986. Losses to date amount to 28.7% of the original urban elm stand.

No systematic survey was conducted by the Forest Insect and Disease Survey in 1987 for elm bark beetles, the carriers of Dutch elm disease, except in Fredericton, where populations of the native elm bark beetle *Hylurgopinus rufipes* (Eichh.) remained low. One adult of the smaller European elm bark beetle *Scolytus multistriatus* (Marsh.), was captured on a sticky monitoring trap. This insect, an important vector in spreading Dutch elm disease in the United States and recently increasing in numbers in southern Ontario, has not been a factor to date in Fredericton. Single adults were captured in pheromone traps in 1982 just south of the city, in 1983 at Tay Creek, some 30 km to the north, and in 1986 in the city on a sticky band monitoring trap.

Québec

In Rivière-du-Moulin Nature Reserve moderate damage occurred on 50% of the white elms. At aux Trembles Island on the Ashuapmuchuan River, there was moderate damage at this new site. In 1987, mortality of young trees, found infected in 1985, occurred in the Saint-Félicien area. At Saint-Pacôme 65% of the elms were severely affected. The New Richmond area also had a high degree of damage.

Ontario

In Eastern Ontario elms infected ranged from 2 to 23%; recent tree mortality was less than 2%. Diseased trees averaged 51% and 19%, with 19% and 11% recent mortality in, respectively, the urban centres of Rainy River and Fort Frances. A rural survey in McIrvine Township disclosed an incidence of 13%, with 4% mortality. Examination revealed 9% of ornamentals diseased in the city of Thunder Bay.

Prairie Provinces

In Manitoba, Dutch elm disease surveys were conducted primarily by the Manitoba Department of Natural Resources, except in Riding Mountain National Park where it was surveyed by Parks Canada. Within the southern part of the province the distribution of the disease remained much the same as in 1987. However, the incidence of infected trees continued to increase in wild stands of elm, but remained comparatively low in the urban areas where control programs were maintained. In Winnipeg, less than 1% of the elm population was infected, while in Brandon it was less than 2%. Most infected trees occurred along river valleys where control measures are less effective. Elsewhere in the province about 77 municipalities reported diseased elms, about the same as in the previous year.

Increases in diseased elms were reported in southern Manitoba, especially along the Red and Assiniboine rivers around Winnipeg, along the Assiniboine to Portage la Prairie, and west of Brandon to St. Lazare. Scattered pockets of diseased trees occurred along smaller drainages in south-central Manitoba in areas near Winkler, Altona, Morden, and Carman. Extensive infections also occurred along the Souris River from southwest of Brandon to the United States border.

During the period from November 1, 1986 to October 31, 1987 provincial sanitation crews removed about 9000 elm trees. An additional 2550 decadent elms were removed from near Brandon and 1081 trees from Winnipeg.

In Riding Mountain National Park, infected elm trees increased along the eastern escarpment of the park. No control action was taken.

In Saskatchewan, intensive surveys of Dutch elm disease and its bark beetle vectors were conducted by the Department of Parks, Recreation and Culture, with cooperation from the Saskatchewan Department of Agriculture, Agriculture Canada, city park departments, and FIDS. No Dutch elm disease infected trees were found in 1987; the most likely spot where the disease may appear first is in southeastern Saskatchewan from infestations along the Assiniboine River west of St. Lazare, Manitoba.

Endemic populations of the native elm bark beetle *Hylurgopinus rufipes* (Eichoff) were present in elm stands in several locations of the province. Eight adults of the smaller European elm bark beetle *Scolytus multistriatus* (Marsh.) were captured in pheromone-baited traps in Regina in 1987, but were not associated with any infected trees.

In Alberta, detection surveys for Dutch elm disease and its bark beetle vectors were conducted jointly by the Alberta Ministry of Agriculture and FIDS in southern Alberta. Pheromone-baited traps and elm trap logs were placed in 16 locations. No bark beetle adults were captured, nor was there any evidence of the disease in 1987.

Scleroderris canker

Ascocalyx abietina (Lagerb.) Schläpfer-Bernhard
(*Gremminiella abietina* (Lagerb.) Morelet)

Scleroderris canker has been detected in all provinces except Prince Edward Island, Manitoba, and Saskatchewan. This disease of conifers is caused by the fungus *Ascocalyx abietina*. At least two races of this fungus (North American and European) have been determined serologically.

North American Race

The North American race of *A. abietina* is widely distributed in Canada and has been a serious problem in nurseries and young plantations for years. Extensive studies of the disease have provided several control recommendations. In eastern Canada the disease is most damaging to pines, especially red, jack, and Scots pines, and often kills them during their first decade of growth. Once the trees are about 2 m high, they are relatively safe from lethal attack. In western Canada, where lodgepole, ponderosa, and whitebark pines are the principal hosts, the disease has occurred at only a few scattered locations in Alberta and British Columbia. No significant damage has been attributed to this disease in either province.

Maritime Provinces

Scleroderris canker was first found in the Maritimes Region in 1971. The disease is widespread in New Brunswick, especially in the northern half of the Province and infects mostly plantations of jack, red, and Scots pine. In Nova Scotia, where the disease was first found in 1972, a few plantations of red, jack, and Scots pine suffered limited lower branch mortality during the mid-1970s. The disease was last found in that Province in 1978, and appears to have died out. It has never been found on Prince Edward Island.

In 1987, after some years of minimal activity, there was an upsurge of new infections in New Brunswick. This is likely the result of ideal weather conditions (wet and cool) during the infection period in 1986. Lower branch discoloration occurred in four jack pine plantations in Victoria County, in one at Deersdale, York County, and in two plantations north Juniper, Carleton County. In some areas the discoloration was severe, indicating heavy infection. Red pine was affected in two plantations near Deersdale and in a 100 ha plantation near Grindstone Brook, Victoria County. Scots pine was infected in a plantation at Galloway, Kent County. All isolates obtained from samples were tested and found to be of the North American race.

Ontario

Reports of the North American race of this disease were scarce in 1987 and in most cases infection levels were low. Exceptions were in Galbraith Township, Blind River District, where surveys in a newfound infection centre revealed 76% of the trees infected and in Haughton Township, Blind River District, where a re-check of a known infection centre showed 60% of the trees infected.

European race

In 1975 a disease syndrome different and more serious than that normally associated with scleroderris canker in North America was reported in New York State. The disease was killing large pine trees and was serologically identified as the European race of *A. abietina*. It has since been detected at scattered locations in Newfoundland, New Brunswick, Québec, and Ontario. Except in Newfoundland, the symptoms and damage caused by the European race have been indistinguishable from those of the North American race.

Newfoundland

A branch sample, taken in late 1985 from a Sitka spruce grown in an experimental provenance plantation established in 1969 near Roddicton, was confirmed in early 1986 to be damaged by scleroderris canker. In 1969 and 1970 eight other provenance plantations were also established throughout the Island using the same stock of seedlings imported from New Brunswick. An examination of these plantations in 1986 showed various amounts of old mortality, recent branch dieback, and top kill. The development of these symptoms appeared to be very gradual. Branch samples were taken from these plantations for cultural identification of the disease and subsequent determination of its race. However, these isolation attempts has so far proved to be positive only for the Roddicton plantation. All trees in this plantation were examined in June 1987 and infection of the various provenances varied from 90-100%. The infected trees were pruned or cut in an attempt to eradicate the disease in this area.

In 1987 additional efforts were made to locate all Sitka spruce plantations established using seedlings from New Brunswick. To date 19 additional plantations have been identified. Some of these plantations have been inspected briefly and many of the trees are in poor condition. All Sitka spruce plantations will be examined for scleroderris canker in 1988

and samples will be collected for cultural identification of the disease.

The incidence of scleroderris canker increased in and around St. John's in 1987. Continued surveys in 1987 also recorded four new locations of this disease. Three of these are in St. John's, involving Scots pine and Austrian pine and one in an old Scots pine plantation on the Salmonier Line. This pine plantation was examined in previous years but no symptoms of infection were recorded. This is the third occasion that scleroderris canker was found on the Salmonier Line, outside the quarantine area.

Cultures of all scleroderris isolates in Newfoundland made before 1987 were serologically diagnosed as the European race. Cultures obtained in 1987 have not been tested for race. Following the results of culturing, the damaged trees will be pruned or cut and burnt in an effort to control the disease.

Maritime Provinces

European and "intermediate" scleroderris canker races have been found in New Brunswick at 11 locations since 1978. Eradication attempts at a forest nursery, in a Christmas tree plantation, and in a commercial plantation appear to have been successful. The disease had been eradicated at three of the 11 locations even before the final race identifications were available. At two locations "controlled" status has been achieved by the pruning of branches to 2 m from the ground. The remaining six locations are "under surveillance", i.e. an annual inspection is conducted for symptoms and/or changes in symptom expression. Where present, samples from branches with symptoms are cultured and tested to determine race. The non-North American race has been identified on more than one occasion at only two of the eight locations under surveillance for at least five years.

The significant aspects of this effort to date are:

(1) The various non-North American races of the disease are indistinguishable in the field from the North American race;

(2) Only branches less than 2 m from the ground have been affected; and,

(3) No non-North American race of the fungus has been identified at any of the locations (or anywhere else in New Brunswick) since 1981.

The findings to date give rise to cautious optimism regarding the future of the non-North American races of scleroderris canker in the Maritimes.

Québec

In 1987, the ministère de l'Énergie et des Ressources Québec conducted a special survey in a section of the administrative region of Estrie. The disease was found in 81 (17.2%) of the 469 pine plantations visited. It was detected at the trace level in 69 of the plantations. Only two were at a high level. Electrophoretic analyses revealed that 70 of the 73 isolates tested were of the European race.

In the summer, 19 red pine plantations in the Estrie and Trois-Rivières regions were pruned because the European race of the fungus was detected there. The plantations mentioned above that are infested with the European race will be given a similar treatment in the summer of 1988.

In conjunction with the pruning program of 1987, all pines growing in a 12.5 km^2 sector surrounding a private nursery in the Trois-Rivières region were carefully inspected for the presence of scleroderris canker. Following this inspection, 800 trees in four plantations containing more than 76 000 red pines were treated.

Ontario

Intensive surveys were again carried out in 1987 with particular emphasis on areas in the immediate vicinity of the known infection centres in Mayo township, Bancroft District, Macaulay township, Bracebridge District and McMurrich township, Parry Sound District. These surveys disclosed four new infection sites in Mayo township, two in Macaulay township, and three in McMurrich township. All these finds were near the original infections and do not represent a significant extension in the range of the European race. Similarly, a single new infection centre discovered late in the field season in Ryerson township, Parry Sound District was only a short distance from other infection sites in McMurrich township and does not represent a major range extension of this pathogen.

European larch canker

Lachnellula willkommii (Hartig) Dennis

Maritime Provinces

European larch canker was first discovered in the Maritimes in 1980. Surveys since then established the distribution of the disease as widespread in southeastern New Brunswick and on mainland Nova Scotia. European larch canker has been a serious disease in many parts of Europe. The fungus is considered to be a primary pathogen (capable of infecting vigorous, healthy trees) and its presence has resulted in the exclusion of larch from plantation programs in parts of Europe. In North America, the fungus was first found in Massachusetts in the 1920s in European larch plantations. Periodic concentrated eradication attempts appeared to have been successful as the disease was not found during surveys of the area in 1965. However, it was discovered in northeastern Maine in 1981.

The fungus infects mostly young trees; therefore, future wood supplies may be affected. Tree mortality reduces stocking, branch mortality reduces growth, and cankers

reduce wood quality. The extent to which the disease will cause damage in the Maritimes is not yet known but the potential for damage is there and the role of the disease will have to be considered in view of increased emphasis on forest renewal and larch tree improvement programs.

In 1987, the disease was not found outside the range of the known distribution during surveys of 87 locations (Figure 8).

Investigation of several aspects of the behaviour of the fungus under local climatic conditions has been initiated. Results will be reported as they become available. A survey to establish age and spread pattern indicates that the fungus could have been present in the Maritimes for about two decades before its discovery and may have spread from specific areas. The study also showed a rapid decrease in incidence of infected trees with increasing distance from the Bay of Fundy, possibly indicating a climatic dependence.

The disease is capable of intensifying rapidly in young stands. Incidence of infected trees in a research plot increased as follows, based on fall assessments: 1982 - 7%, 1983 - 19%, 1984 - 46%, 1985 - 88%, and 1986 - 91%. Considering the high level of incidence, no further assessments are planned.

Decline, dieback, and stress-related disorders

Maple Dieback and Decline

Much has been said and written in recent years about the sugar maple decline affecting vast areas of eastern North America, especially Québec, and on its effects on the maple sugar industry and other forestry-related activities.

Opinions on the cause of decline vary greatly, and they encompass weather patterns, mineral deficiencies, changes in soils, forest pest conditions, air pollution, ozone damage, forest management practices, and acid rain.

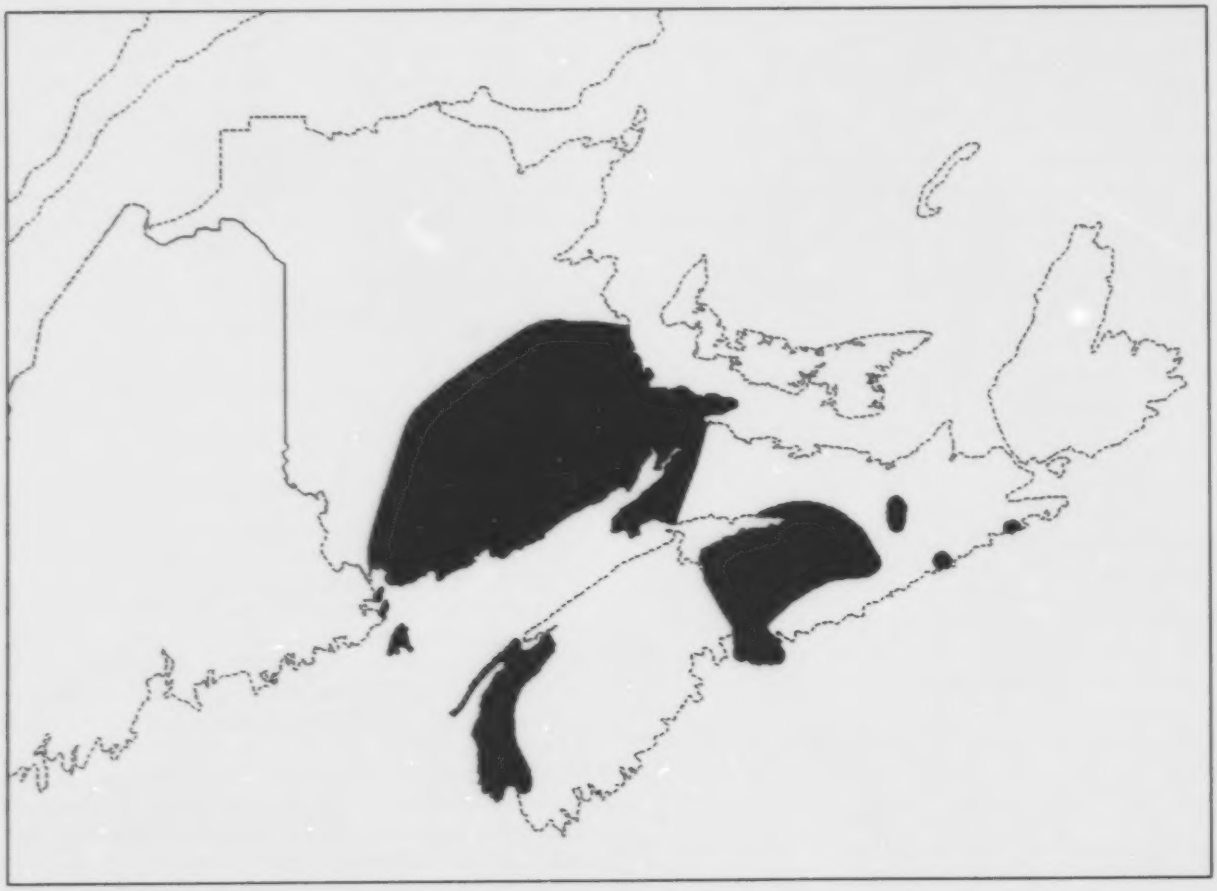

Figure 8: Distribution of European larch canker in the Maritimes, 1987.

Maritime Provinces

In New Brunswick in 1986, surveys identified some sugar maple stands deteriorating but the phenomenon was not widespread. In 1987 an aerial survey was conducted over much of the Province, covering parts of York, Carleton, Victoria, and Madawaska counties, to gain a better overview of where declining stands exist. This area was selected partly to follow up on results of the 1986 survey, and partly because of its proximity to Quebec and the northeastern United States. The survey was a cooperative effort of the Forest Insect and Disease Survey and the New Brunswick departments of Natural Resources and Energy, Municipal Affairs, and Environment.

Branch and, occasionally, stem mortality were found in pockets in all four counties. The largest affected area was in an uninhabited part of the Madawaska panhandle along the Québec border. The intensity of deterioration in the affected stands was variable but, in some of the smaller pockets, upper crown branch mortality was observed on more than half of the trees, notably in areas near North Branch Becaquimec Stream and Elliott Brook, Carleton County and in parts of the upper Green River and Quisbis River drainage systems, Madawaska County. The cause of the deterioration was apparent during ground checks in some of the areas and included past cutting practices, insect or disease damage, and current management practices. In other affected areas, however, no obvious reasons were found to explain the deteriorating condition of the trees. Permanent plots will be established in stands selected from these and decline symptoms will be monitored along with pest levels, soil nutrient status, and other factors possibly involved with the decline of these trees.

No unexplained decline was found in either Nova Scotia or Prince Edward Island. Deterioration in a maple syrup production area in Guysborough County, Nova Scotia was related to previous defoliation by greenstriped mapleworm and whitemarked tussock moth and the presence of sugar maple borer (185 of the trees in the stand infested). In a stand in Cape Breton County, Nova Scotia, overthinning of the exposed trees, especially near the top of the hill, to the effects of strong winds and sunscald made them more vulnerable. Trees on the four sugar maple condition-monitoring plots were generally healthy, with only a few minor foliage pests present.

Québec

For close to 10 years, the dieback phenomenon affecting maple stands and hardwood forests has constituted a major problem for maple growers and other users of hardwoods. Ever since it was first observed toward the end of the 1970s in the Beauce, Amiante, and Bois-Francs regions, the situation has steadily deteriorated, gaining in intensity and widening in scope. Areas that were not affected in the early 1980s now show unmistakable signs of dieback and, from year to year, the phenomenon becomes more serious.

In 1983, the Service de la recherche appliquée established a network of sample plots to determine the causes of dieback, correlate the development of the phenomenon with various ecological variables, and also to find solutions to the problem. For 1983 to 1987, 265 semipermanent sample plots were established in order to cover a major portion of the hardwood forests in Québec. The area south of the St. Lawrence was covered from Matane to Huntingdon, and the north shore was covered from Montmorency to Témiscamingue.

Stands on the dry crests of hills or in wet areas were most severely affected. In addition, stands subjected to clear-cutting operations over the past few years proved to be far more susceptible. It was also found that trees with decay or cankers or infested with plant-eating insects suffered much more seriously from dieback and that the condition developed more rapidly in these trees.

In addition, annual estimates of dieback in the sample plots established since 1983 indicate that the phenomenon is progressing at a constant rate. Figure shows that in the 246 sample plots the percentage of missing foliage rose from 23.8% in 1986 to 28.1% in 1987. During the same period, the percentage of affected trees increased from 76.0% to 84.7%.

Research is now aimed at finding ways of making the trees and stands more resistant to dieback. Experiments using fertilizers and lime are in progress. One experiment involving semi-operational fertilization has been implemented in 100 maple stands in the Appalachian Mountains and in 10 maple stands in the lower Laurentians. These measures should correct imbalances and disturbances in the nutrient cycle in the soil and leaf tissues that, according to our latest understanding of the phenomenon, are due to air pollutants.

For the fifth consecutive year, the Service de la protection contre les insectes et les maladies (SPIM) conducted an aerial survey aimed at determining the scope and severity of maple dieback in Québec. In 1983 and 1984, there were aerial surveys in the regions considered to be the hardest hit by dieback, i.e., in the region bounded by Montmagny and Victoriaville. In 1985, the survey covered the entire Appalachian Mountain region. The north shore of the St. Lawrence River from Québec City to Mont-Tremblant Park, as well as the Bas-Saint-Laurent—Gaspésie region, were surveyed in 1986. In 1987 the aim was to complete the dieback survey across the province.

The aerial survey conducted in 1987 covered mainly the areas between Mont-Tremblant Park and the Témiscamingue region. One area within the Montréal region, between the municipalities of Grenville, Saint-Jérôme, and Terrebonne, as well as the sugar bush area along the Saguenay River, were also surveyed. It was necessary to eliminate the southwestern Témiscamingue from the program because of a forest tent caterpillar infestation in maple stands in that region. Caterpillar-induced defoliation made it impossible to estimate maple dieback in that part of the province. The survey finally covered an area of 39 600 km^2 over the period extending from July 27 to August 19. The

maple stands themselves covered 9643 km^2, or 24% of the area surveyed.

Estimates of levels of dieback were based on the proportion of foliage that was missing from the entire stand. Four classes of dieback were established; up to 10% absent foliage (healthy or only slightly affected), 11% to 25% (light defoliation), 26% to 50% (moderate defoliation), and 51% and over (severe defoliation).

The collated results of the aerial survey are included in Table 7. In the entire region surveyed by aircraft, close to 49% of the maple bush area fell in the "healthy or slightly affected" class. The damage reported was generally minor (50.4% of the area came within the "light" class), but it was scattered throughout the surveyed zone. The proportion of dieback-affected maple stands was higher in the Montréal administrative region (64%) than in the Abitibi - Témiscamingue (48%), Outaouais (45%), and Saguenay—Lac-Saint-Jean (37%) regions.

In general, areas east of the Gatineau River were more severely hit by the phenomenon than those in the western portion of the land surveyed in 1987. In the Montréal region, the survey revealed light damage scattered throughout. Symptoms of dieback were to be found everywhere. This area, bounded by the municipalities of Grenville, Saint-Jérôme, and Terrebonne surrounds a densely urbanized zone. Although light damage was recorded throughout the valley of Lièvre River, there were a number of pockets of moderate dieback to the northwest of L'Annonciation. In the Outaouais region, dieback was generally observed in fragmented areas scattered throughout. A larger strip of forest land with light symptoms of dieback was observed northeast of Hull, within the rectangle bounded by Hull, Gatineau Park, Notre-Dame-du-Laus, and Duhamel. Damage was greater (moderate) in some small patches between Quyon and Fort-Coulonge and northeast of Rapide-des-Joachims as well as east of Lake Dumoine. Maple forests in the eastern Témiscamingue displayed signs of light damage in close to 48% of the area surveyed. The phenomenon was also observed in the Saguenay—Lac-Saint-Jean region, although not to the same degree as in the other aforementioned regions.

Ontario

In 1987, in response to continuing concern about the health of sugar maple in Ontario, the FIDS Unit established 70 permanent sample plots throughout the range of sugar maple. The plots (25 trees each) were randomly located in mature and overmature stands. Each of the 1750 trees was measured and scrutinized for general crown and foliage condition, specific dieback symptoms, stem defects, and various insect disease and abiotic conditions. A summary of the results of this work showed 87% of the trees were healthy, 10.8% had minor dieback symptoms, 2.0% showed moderate-to-severe dieback symptoms, and 0.2% were dead. In all cases, damage to trees was a normal deterioration expected in stands of these age classes. Plans are to establish an additional 70 plots during the 1988 field season; all 140 plots will be examined annually.

Red Oak Decline

Ontario

The FIDS Unit has maintained 13 plots of 100 oak trees across southern Ontario for the past 11 years. The plots were established in 1977 to monitor oak decline which became apparent during an outbreak of the oak leaf shredder, which has since subsided. The overall condition of the stands has improved over the past several years, although some 155 of the original 1300 trees (approximately 12%) have died. Nine

Table 7. Areas (ha) of dieback-affected maple stands in the regions surveyed by aircraft, 1987

Administrative regions	Management units	Dieback classes								Total
		Healthy or slightly affected (up to 10%)		Light (11 to 25%)		Moderate (26 to 50%)		High (51% and over)		
		(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)
Saguenay-Lac Saint-Jean (01)	21	4 456	62.1	2 675	37.3	44	0.6	-	-	7 175
	23	1 669	64.3	900	34.7	25	1.0	-	-	2 594
	Total	6 125	62.7	3 575	36.6	69	0.7	-	-	9 769
Québec (03)	33	131	23.1	419	73.6	19	3.3	-	-	569
	Total	131	23.1	419	73.6	19	3.3	-	-	569
Montréal (06)	61	22 725	33.1	44 568	64.9	1 350	2.0	-	-	68 643
	62	1 788	29.5	4 263	70.2	19	0.3	-	-	6 070
	63	31	6.9	394	86.2	31	6.9	-	-	456
	64	87 425	36.5	150 632	62.9	1 532	0.6	-	-	239 589
	Total	111 969	35.7	199 857	63.8	2 932	0.5	-	-	314 758
Outaouais (07)	71	119 488	57.2	85 845	41.1	3 444	1.7	125	-	208 902
	72	109 672	50.2	107 601	49.3	1 157	0.5	-	-	218 433
	73	89 794	59.4	60 551	40.0	894	0.6	6	-	151 245
	74	2 338	94.7	131	5.3	-	-	-	-	2 469
	Total	321 296	55.3	254 128	43.7	5 495	1.0	131	-	581 049
Abitibi-Témiscamingue (08)	81	30 306	52.1	27 538	47.3	338	0.6	-	-	58 182
	Total	30 306	52.1	27 538	47.3	338	0.6	-	-	58 182
TOTAL		469 836	48.7	485 517	50.4	8 853	0.9	131	-	964 327

of the 155 trees succumbed in 1987. The bulk of the mortality and badly damaged trees were in the Central Region, the area hardest hit by oak leaf shredder and where there are indications of a resurgence in numbers of this potentially destructive insect.

Aspen Decline

Maritime Provinces

Trembling aspen is of consequence in the forest inventory of all three Maritime provinces and the condition of this species should be of concern to forest managers. In our region trembling aspen has been exposed to a great variety of stresses in recent years. Outbreaks of insects such as the forest tent caterpillar, casebearers, poplar serpentine leafminer, infection by diseases such as Hypoxylon canker, twig and leaf blight, leaf spots, and leaf rusts were all factors contributing to stress. Drought in some years was a significant added factor.

A survey in 1985 found that the majority of trembling aspen stands exhibiting the most serious stress symptoms were in eastern New Brunswick, the northern half of western Nova Scotia, and in Prince County, Prince Edward Island; that dieback was present on 32%, 34%, and 37% of the trees, respectively, in the three provinces and that more than half of the trees examined in all three provinces were healthy.

In late May and early June 1987 trembling aspen individuals or small groups of trees displayed crowns with small, misshapen, and off-colored foliage. Some of the affected trees had only a few abnormally large leaves scattered along the branches. The condition was most prevalent in parts of York, Northumberland, Carleton, and Victoria counties in central New Brunswick but was also present at scattered locations throughout the northern half of the Province. As the season progressed, the crowns of these trees became fuller and the symptoms were less pronounced. However, many trees in the more severely affected areas never attained full crown density. We have no explanation for this condition.

In the early fall of 1987 a survey was conducted similar to the one in 1985, except that selection of assessment plots was concentrated more in areas of known stress factors, such as the repeated severe defoliation by forest tent caterpillar during the recent outbreak.

The number of areas assessed in the Region was 56: 27 in New Brunswick, 23 in Nova Scotia, and 6 in Prince Edward Island. Of the 1400 trees classified, 25 at each location, less than 1% were in the suppressed category. Results indicate that the trembling aspen resource is indeed in a seriously deteriorating condition, especially in New Brunswick where at least 80% of the trees show some sign of stress in all of the areas examined. The proportion of trees affected by Hypoxylon canker was 16.4%, considerably higher than the 11% infection rate found during surveys conducted in the late 1970s.

Special Surveys

Cone and seed pests

Maritime Provinces

The establishment of seed orchards created high value areas in the Maritimes Region. Seed orchards and seed production are important to nursery programs, and anything that interferes with orchard productivity affects most other phases of forestry operations aimed at future wood production. Forest pests in seed orchards, both insects and diseases, have the potential to seriously affect seed production, either directly, by destroying seed or cones, or indirectly, by affecting the condition of trees, thus interfering with their ability to produce seed.

Insects - The spruce seed chalcid, *Megastigmus atedius atedius* Wlk., was the major seed problem encountered and was present in high numbers in a white spruce orchard in New Brunswick.

Other seed/cone insects, found in small numbers on a few scattered trees in New Brunswick, included the spruce cone maggot *Hylemya anthracina* (Czerny), in seed orchards of white spruce and black spruce and in a white spruce breeding garden, fir coneworm *Dioryctria abietivorella* (Grt.), in a jack pine seed orchard, and another coneworm, *Dioryctria* sp., in two black spruce seed orchards.

There were only a few insects that affected trees but not directly cones or seeds, and the damage they caused was minor. The species included yellowheaded spruce sawfly *Pikonema alaskensis* (Roh.), a looper *Caripeta* sp., and a weevil *Hylobius* sp. Cutworms, *Polia* sp., were found in several clonal orchards with grass cover. Although larvae were found on the tree, no damage was done to the grafts.

Aphids and mites caused major problems in seed orchards and breeding gardens in all three Maritime provinces. Populations were very high in many areas, probably aided by the hot, dry summer and persisted at some locations despite control programs.

Spider mites, *Tetranychidae* spp., were found at varying population levels in virtually all of the tamarack seed orchards and breeding gardens in the Region. A species of *Oligonychus* was widespread, often in considerable numbers, but generally caused minimal damage except in a jack pine seed orchard in New Brunswick where needle discolouration was moderate to severe.

Cinara spp. aphids were often present in conjunction with spider mites. Damage attributable to each could not always be distinguished but control for aphids was generally more effective than for mites. *Cinara* spp. were found on tamarack in New Brunswick and Prince Edward Island, on white spruce in New Brunswick and Nova Scotia, and on red spruce in Nova Scotia. Eastern spruce gall adelgid *Adelges abietis* (L.) caused moderate damage in a white spruce seed orchard in New Brunswick and affected white spruce and red spruce trees in Nova Scotia. Ragged spruce gall adelgid *Pineus similis* (Gill.) was present but caused little apparent damage to white spruce in New Brunswick and red spruce in Nova Scotia. Pine leaf adelgid *Pineus pinifoliae* (Fitch) was an isolated find on white spruce in New Brunswick.

Disease - Scleroderris canker *Gremmeniella abietina* (Lagerb.) Morelet caused severe infection in a jack pine seedling orchard in New Brunswick. All branches from the lower two or three whorls were pruned and burned in an effort to control the disease.

Armillaria root rot *Armillaria mellea* (Vahl ex Fr.) Kummer is present in a number of seedling orchards in both New Brunswick and Nova Scotia and has caused some tree mortality. Monitoring plots established in several orchards will provide information on the significance of this disease.

Globose gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka was found in several jack pine seedling orchards and one clonal orchard in New Brunswick. Control operations have been initiated.

Sirococcus shoot blight *Sirococcus conigenus* (DC) P. Cannon & Minter was found on cone scales originating from a white spruce seed orchard in Nova Scotia.

Needle rusts on the various hosts were of no consequence in 1987, as infection levels have been greatly reduced from those of the past few years. *Chrysomyza* spp. were present on white spruce and red spruce in Nova Scotia, and *Melampsora* spp. on tamarack in Prince Edward Island, all at the trace level.

Abiotic causes - The dry summer in 1987 caused problems mostly in Nova Scotia where the drought was most severe. High tree mortality occurred in a newly established red spruce orchard that had no irrigation system.

Fertilizer burn in black spruce, red spruce, and white spruce orchards in Nova Scotia may have also been an indirect effect of the lack of precipitation. It seems that, although correct procedures were followed in applying various fertilizers, irrigation may not have been adequate to move these away from the roots and the high concentration of chemicals damaged seedlings.

Québec

In 1987, over 753 000 trees were inspected in tree orchards. Over 90% consisted of black spruce (58.3%) and jack pine (32.6%). The other species included white pine (5%), white spruce (2%), larch (0.7%), red pine (0.7%), Norway spruce (0.6%), and Scots pine (0.1%). The white pine weevil, root decay, rodent damage, and spruce budmoths caused the greatest problems. In the Bas-Saint-Laurent—Gaspésie administrative region, the spruce budmoth *Zeiraphera canadensis* Mut. and Free. was observed in a white spruce seed orchard, but there was no apparent damage to the trees. Rodent damage was recorded in a tamarack seed orchard. Only trace damage was observed in the Québec administrative region. In the Trois-Rivières administrative region, root decay on jack pines caused only trace damage. The white pine weevil *Pissodes strobi* (Peck) was active in seed orchards in the Montréal and Abitibi - Témiscamingue administrative regions. In the first of these regions, recent attacks of the pest on white spruce, Norway spruce, and Scots pine inflicted light and heavy damage. Serious damage was also recorded in a seed orchard with 1500 Norway spruces. Of this number, 72% suffered weevil-inflicted damage. In the Abitibi - Témiscamingue, the pest caused only trace damage in two seed orchards.

Ontario

Cone and seed surveys concentrated on white spruce in 1987 in both northern and southern Ontario. The survey was part of an ongoing program to investigate and gather baseline data on pests affecting cone and seed production on major coniferous tree species. Each ranger attempted to gather 100 mature, but still green, cones and these were submitted to the laboratory for dissection and analysis. Although the effort was hampered by a poor cone crop 999 cones were submitted from 10 locations across the province.

Of this total, 54% were damaged. Actual seed loss averaged 30% while seed loss within damaged cones averaged 57%. The principal agents causing the damage included the spruce cone maggot *Lasiomma anthracina* Czerny, the spruce cone axis midge *Dasineura rachiphaga* Tripp, the spruce seed moth *Cydia youngana* (L.) [=*youngana* (Kft.)], and the spruce cone gall midge *Dasineura canadensis* Felt.

British Columbia

Cone crops were generally light to occasionally heavy in interior forests and rare in coastal areas. Cone and seed pests were at the highest levels in recent years due in part to favorable overwintering conditions. Western spruce budworm, widespread at epidemic levels, also contributed to a high incidence of damage in at least two seed orchards. A Douglas-fir coneworm *Dioryctria pseudotsugella* Moonier, and a fir coneworm *D. abietivorella* (Grt.) infested most cones throughout the Kamloops Region and parts of the Cariboo and Vancouver regions. Douglas-fir cone moth *Barbara colfaxiana* (Kft.) infested up to 85% of the cones (average 28%) at 34 sites in four regions, although most of the damage occurred in the Kamloops Region and the eastern part of the Nelson Region. Spruce cone maggot *Lasiomma anthracina* (Czerny) infested up to 80% of white and Engelmann spruce cones at 12 sites mainly in the Prince Rupert, Prince George, and Nelson regions. A spruce seed moth, *Cydia strobilella* (L.), infested up to 70% of the white spruce cones in northern regions and up to 85% of the Engelmann spruce near Creston in the Nelson Region. A pine cone borer, *Eucosma rescissoriana* Heinr., infested 30% of the shore pine cones at Mayer Lake Provincial Park on the Queen Charlotte Islands; this was the first record of the insect on the islands.

Ten coastal and two interior seed orchards were surveyed in 1987. For the second consecutive year Cooley spruce gall adelgid *Adelges cooleyi* (Gill.) severely infested Douglas-fir and up to 25% of the Sitka spruce in five coastal seed orchards. Balsam woolly adelgid *Adelges piceae* (Ratz.) lightly infested twigs of up to 35% of the amabilis fir in three orchards near Victoria and another near Nanaimo; all are within the infestation and regulation zones. A previously undescribed gall midge, *Contarinia* sp., galled buds of yellow cedar seed orchard stock at three locations on southern Vancouver Island. Up to 4% of the male and 2% of the female cones at one location were affected. Western red cedar midge *Mayetiola thujae* (Hed.) damaged up to 40% of the cones in two orchards. Control actions using Dimethoate were implemented in most coastal seed orchards against moderate-to-high populations of Douglas-fir gall midge *Contarinia oregonensis* Foote (90% of cones infested), Douglas-fir cone moth *Barbara colfaxiana* (Kearfott) (45%), and fir coneworm (55%). Ground and aerial applications of Sevin® and *Bacillus thuringiensis* were made at the Skimikin seed orchard against high numbers of western spruce budworm.

Pinewood nematode

Bursaphelenchus xylophilus (Steiner and Buhrer) Nickle
Reported as *B. lignicolus* in 1985 FIDS report

The pinewood nematode has gained worldwide attention in recent years because of its implications to the international trade in forestry products.

The organism was first identified in North America in the late 1970s and was believed to have been imported from Japan, where it has been reported to have killed trees for at least 30 years. The pinewood nematode has been reported to be widely distributed in the United States and, in 1982, was reported in southern Manitoba. In 1985 the nematode was found in Ontario.

The pinewood nematode is a plant-parasitic species that kills trees by rapidly multiplying in the water-conducting elements, after having been introduced into the trees by wood-boring insects. Cerambycids are known vectors but wood-boring beetles may also be responsible. The affected tree, with its water supply cut off, wilts and dies within a short time. The fact that many species of nematodes, mostly non-pathogenic, may be present in trees and that the identifica-

tion of these microscopic organisms is extremely difficult, has resulted in confusion as to the cause of tree mortality in some areas. This has made it difficult to plot the actual distribution of the pinewood nematode.

Newfoundland

Surveys conducted in cooperation with Memorial University to detect the pinewood nematode and define its insect vectors were continued in 1987. A total of 98 wood samples were collected from healthy, damaged, and recently dead trees of tamarack, white spruce, Sitka spruce, black spruce, balsam fir, white pine, and Scots pine, particularly from locations across the Province that had not been previously sampled. About 25% of the samples contained some nematodes, but not the pinewood nematode. *Bursaphelenchus xylophilus* "m" form was isolated from three tamarack samples and from one black spruce sample near Lake Ambrose, central Newfoundland. It was also found in one tamarack and one balsam fir sample on the Burin Peninsula, eastern Newfoundland. These results confirm the presence of *B. xylophilus* "m" form in living tamarack and records an addition to the six locations previously reported for Newfoundland.

Probable insect vectors of the pinewood nematode were collected near freshly cut and piled host trees at three locations and from a commercial wood chip pile. A total of 65 specimens of bark beetles, weevils, wood wasps, and wood borers were collected and several contained nematodes, but the pinewood nematode was not found.

Maritime Provinces

In the Maritimes, the pinewood nematode has been a special concern of FIDS since 1980. Through general observations, forest condition assessment surveys, plantation surveys, pest extension activities, provincial cooperative surveys, and special surveys, staff have been on the lookout for trees displaying symptoms. In the five years from 1980 to 1984 inclusive, 15 such trees were located. These included red pine, Scots pine, white spruce, and balsam fir. Nematodes were extracted from some of these and submitted for expert identification. Results indicated that none of the samples submitted were of the pinewood nematode. In 1984 suspect nematodes were extracted from two samples (one a balsam fir, one a white spruce). One sample contained two species of nematodes, a bacterial feeder and a mycophagous species (fungus eater). The nematode from the other samples was identified as 'definitely not pinewood nematode'. Also in 1984, a number of bark beetles from stressed balsam fir were tested as possible vectors for the pinewood nematode, with negative results.

In the fall of 1985 and the summers of 1986 and 1987 a special survey was conducted in the Maritimes as part of a national effort to establish the presence and distribution of the pinewood nematode in Canada. Recently dead, old dead, and a few living trees were sampled from a number of locations. Insects, considered possible vectors for the nematode, were also analyzed. In total, samples were obtained from 207 locations, 131 in New Brunswick, 55 in Nova Scotia, and 21 in Prince Edward Island.

Although the objective was to obtain a good species mix in sampling, balsam fir received special attention, especially in the early part of the survey, because of the similarity in symptom expression between Stillwell's Syndrome and the supposedly sudden wilting of conifers when killed by the pinewood nematode. No pinewood nematode has been identified from any of the balsam fir trees that succumbed to Stillwell's Syndrome.

The "r" form of *B. xylophilus* has been identified at five of the 207 locations (2.4%) and from seven of the 397 trees (1.8%) sampled, all in New Brunswick and all from dead pine trees, as follows:

1. Nevers Brook, Kent County, N.B. (UTM: 20-30-513). Isolated from one recently dead jack pine tree from a group of trees that died in a root rot infection pocket. The number of pinewood nematodes was given as "10 000+ specimens". This tree, cut and sampled in 1986, was resampled in 1987 when 17 specimens of pinewood nematode were found.

2. Nevers Brook, Kent County, N.B. (UTM: 20-30-513). The location is less than 1 km from the previous area. Isolated from one of two old-dead and from one of five recently dead jack pine trees from a small group of porcupine killed trees. There were 17 specimens of pinewood nematode isolated from the old-dead tree and a "large population" from the recently dead tree.

3. Jeanne Mance, Gloucester County, N.B. (UTM: 20-31-524). Pinewood nematode isolated from two recently dead jack pine trees. The cause of death was not determined but there were only 20 and 6 specimens isolated from the two trees, respectively.

4. Mount Hebron, Kings County, N.B. (UTM: 20-30-507). Isolated from one windthrown jack pine tree in a 13-year-old plantation. The number of pinewood nematodes was given as "100+ specimens".

5. Pleasant Mountain, Albert County, N.B. (UTM: 20-33-507). Pinewood nematode was isolated from one of two recently dead eastern white pine trees sampled. The number of specimens was given as "100+".

Another *Bursaphelenchus*, the "m" form, which is an affiliate of uncertain connection and is considered nonpathogenic, has been identified at 10 sites in New Brunswick and nine in Nova Scotia. Two trees were infested at two locations; in the other areas only individual trees were positive for the "m" form. Of the 21 infested trees, 14 were balsam fir and there were one each of black spruce, red spruce, Scots pine, eastern white pine, and jack pine. All but one of the trees from which the "m" form was extracted were recently dead, the exception being an old-dead eastern white pine tree from Nova Scotia. The highest number of "m" form

nematodes extracted from infested trees was 18, with an average of 8.3 per tree. There is no evidence to justify the pinewood nematode in the Maritimes as an organism of biological importance (i.e. a tree killer) but the consequences of its presence may be economically significant if it affects our ability to export some forest products, such as wood chips, because of plant quarantine-related regulations in other countries.

Québec

The pinewood nematode surveys conducted by the Canadian Forestry Service in 1985 and 1986 concentrated primarily on detecting the presence of the nematode in natural forests. Since the 1986 report, there has been little change in the situation, because most of the samples earmarked for identification in 1986 had not yet been processed by the fall of 1987.

This year, a special study was conducted by FIDS-Laurentian Forestry Centre on potential nematode vectors. Insects, especially longicorns, were collected from recently cut logs stacked by the side of forest trails. Anywhere from a few to 20 specimens/species/site were collected from 32 locations in the province. These sampling sites were located mainly in the St. Lawrence River valley, mostly between Rimouski and Hull, and in the Saguenay—Lac-Saint-Jean region.

The most commonly caught insect was the sawyer beetle *Monochamus scutellatus* (Say) on stacks of fir logs. Insects were also collected on stacks of black spruce, jack pine, white pine, and red pine logs. The insects were sent to Memorial University in Newfoundland for identification.

Ontario

Surveys during the past several years have shown that both the "r" and "m" forms of this organism are present in Ontario forests. However, an analysis of the survey results in 1986 seemed to indicate that only the "m" form was present on balsam fir and spruce. Accordingly, surveys in 1987 concentrated on attempting to determine which form of the nematode is present on spruce and fir in Ontario. In addition, preliminary work was begun on determining the impact of the organism on stands in which it has been found to date. Some 175 samples were submitted to the laboratory of which 76 contained nematodes. Of these, 60 samples contained the pinewood nematode. All the samples from balsam fir and white and black spruce contained the "m" form only, although two samples from balsam fir are still being analyzed. Several samples from pine contained both forms and one sample from white pine contained only the "m" form.

Prairie Provinces

An extensive survey was conducted by FIDS in the three prairie provinces in 1986 as part of a nationwide survey to detect the presence, distribution, and tree host species of the pinewood nematode. Wood discs were collected at 49 locations; 20 in Manitoba, 14 in Saskatchewan, and 15 in Alberta. At each location, three wood discs were collected from recent dead/dying coniferous tree species, and similarly from adjacent live trees for comparison. As many as three and four different conifer species were sampled at each location. All wood discs were processed at the Northern Forestry Centre following standard nematode extraction procedures. In addition, about 12 specimens of adult *Monochamus* and *Xylotrechus* species of woodborers were dissected and extracted for nematodes and several wood and frass samples associated with the bark beetles, *Dendroctonus murrayanae* and *D. valens*, were examined.

Up to 1987, only a portion of the extracted nematode samples had been identified by the Biosystematics Research Institute in Ottawa. The pinewood nematode ("m" form) was extracted from either balsam fir or white spruce at three locations: near Whitecourt and near Lac La Biche, Alberta and near Candle Lake, Saskatchewan. The "r" form of the pinewood nematode was extracted from either jack pine or lodgepole pine, also at three locations, near Smoky Lake and in the Cypress Hills, Alberta, and at Clearwater, Manitoba. A large number of nematode species other than *Bursaphelenchus xylophilus* were identified in the wood samples submitted, while *Tylenchid* spp. were associated with the woodborer and bark beetle species.

Stillwell's Syndrome

Balsam fir trees, usually with a fair complement of foliage and after exposure to varying amounts of defoliation by the spruce budworm for several years, sometimes turn bright red and die. This phenomenon has been known in stands where considerable damage or mortality has already occurred. The sudden demise of surviving trees in spruce budworm-damaged stands during the apparent recovery stage, even years after the collapse of the outbreak, was noted by the late M.A. Stillwell during his pathological studies in the Green River Watershed of New Brunswick. We proposed that this phenomenon be known as Stillwell's Syndrome in the researcher's honour in 1982, when FIDS first drew attention to this condition.

Balsam fir trees stressed by repeated spruce budworm defoliation are susceptible to attack by numerous organisms that are normally considered to be of secondary importance. Investigations in 1982 into the possible cause of Stillwell's syndrome found that all red trees sampled were affected by Armillaria root rot and at least one species of beetle. Balsam bark weevil *Pissodes dubius* Rand was present in 75% of the affected trees, balsam fir bark beetle *Pityokteines sparsus* (Lec.) in 17%, and sawyer beetle *Monochamus* sp. in 17%. Observations elsewhere indicate that not all Stillwell's syndrome-killed trees are affected by Armillaria root rot, that balsam bark weevil and balsam fir bark beetle frequently occur together on the same tree, and that sawyer beetle attack of weakened living trees is not uncommon.

The sudden death of balsam fir trees was reported in 1980 and 1981 from various parts of New Brunswick. In 1982, an unusually high number of balsam fir trees died in this manner and some areas of Nova Scotia were affected. The condition was present but much reduced in 1983, increased again in 1984, and continued in 1985, especially in the northwestern part of New Brunswick. The problem intensified in New Brunswick in 1986 and thousands of balsam fir trees with bright red foliage were observed during early summer aerial surveys in the western part of the Province.

In 1987, in New Brunswick, the number of balsam fir trees with red foliage was greatly reduced in much of the western part of the Province compared to 1986 levels. Exceptions were a 45 000 ha area in the Christmas Mountain Range in northwestern Northumberland County, and a 10 000 ha area of Glazier Lake, Madawaska County. Scattered red trees were present throughout the rest of western New Brunswick and a few recently dead trees were observed in the eastern half of the Province.

In Nova Scotia, balsam fir trees, dead as a result of Stillwell's Syndrome, were observed throughout the spruce budworm-damaged forest of the northern mainland but the number of affected trees was low.

In Prince Edward Island, no affected trees were observed in 1987.

Québec

In 1986 reddish foliage was observed on fir trees growing either in isolation or else in small clusters in several conifer stands in the province. The study showed that these trees were rapidly killed by a severe attack by one or more species of bark-boring or other xylophagous insects.

In order to observe how the situation was evolving, we established three semipermanent study plots in stands exhibiting relatively substantial damage. The first one was located near Joliette in a balsam fir stand which had suffered sleet damage in the fall of 1983. The other two plots were established in stands that had been seriously infested with the spruce budworm a few years earlier. One was near Lake Laflamme in the Montmorency Forest in the Laurentides Reserve and the other, near Trinité-des-Monts (Rimouski). At each location, groups of 70 to 87 firs, including some reddened specimens, were selected and marked. The same trees were re-assessed in 1987.

The mortality rate, i.e., firs with reddening foliage, increased by 3% and 8% in Joliette and at Lake Laflamme, respectively, but remained unchanged in Trinité-des-Monts. Likewise, there were far more new cases of resinosis in the first two locations than in the third. Resinosis indicates fresh attacks by borers.

This type of bark borer infestation is normal in highly stressed stands and generally lasts only a few years. The situation should soon stabilize in Joliette and at Lake Laflamme, as it seems to have already done in Trinité-des-Monts.

Acid Rain National Early Warning System

Acid rain has been a global concern for the past few years as effects of impurities in the air on lakes, buildings, and the forest are becoming more apparent. Acid rain means more than just rain with lower than normal pH falling from clouds that come from elsewhere. It includes any form of acid precipitation, both wet and dry, and air pollutants of different kinds from both near and far.

Concern over the future of Canadian forests has intensified as a result of the alarming tree mortality observed in other parts of the world. The Acid Rain National Early Warning System (ARNEWS) came into being in the early part of 1984 when the Canadian Forestry Service established a national program to detect early signs of acid rain damage to Canada's forests.

The objectives of the program are:

1. To detect possible damage to forest trees and soils caused by acid rain and to identify damage not attributable to natural causes or management practices;

2. Long-term monitoring of vegetation and soils to detect future changes attributable to acid deposition and other air pollutants in representative forest ecosystems.

The Forest Insect and Disease Survey was charged with the responsibility for (i) plot establishment, (ii) aboveground parameter monitoring and sampling, and (iii) providing assistance in obtaining foliage and soil samples for chemical analysis.

Permanent plots are to be maintained in all Regions of Canada to monitor:

a. Changes in the condition of forest stands;

b. The presence and fluctuation of biotic and abiotic factors that effect the condition of the forest (insects, diseases, stand changes, temperature, etc.);

c. Symptoms that indicate factors not attributable to the above that could conceivably be early signs of acid rain damage; and,

d. The effect of acid rain on the condition of various economically important tree species.

The rationale is that, without close monitoring of all of the factors mentioned, the expected, initially subtle, effects of acid rain cannot be isolated and identified. Forest Insect and Disease Survey personnel are always on the lookout for unusual or unexplained forest conditions, some of which may point to acid rain damage.

Newfoundland

In Newfoundland eight permanent plots have been established and are being monitored. The analysis of foliage and soil samples has not commenced yet. Presently, there is no evidence of any noticeable effect of acid rain in the forests of Newfoundland.

We also established and maintained contact with other federal and provincial government agencies working on various aspects of acid rain. These agencies include the Department of Fisheries and Oceans, the Inland Waters Directorate, the Atmospheric Environment Service, and the Environmental Protection Service of Department of Environment, the Newfoundland Department of Environment, and the Memorial University of Newfoundland. Representatives of these agencies formed the "Newfoundland Acid Rain Technical Group" (NARTG) which meets twice a year for exchange of information.

Maritime Provinces

In the Maritimes Region 15 permanent ARNEWS plots representing the important forest species and geographical areas were established in 1984. Two additional plots were established in northwestern New Brunswick in 1985 at the request of and in cooperation with Fraser Inc. These last will be monitored jointly with the company in future years.

In 1987, all plots were visited monthly from June to September to determine forest insect and disease conditions, detect 'acid rain' symptoms, observe seed crop and premature fall discolouration, collect ground vegetation samples, and sample lichens and mosses found on trees. In August, detailed assessments of all plots were carried out following procedures developed by the Maritimes FIDS unit for the national system.

Foliage and soil samples are now available for analysis from all 17 ARNEWS plots in the Maritimes. Information from increment cores collected in 1984 has been computerized in cooperation with the Petawawa National Forestry Institute.

Tree mortality on all ARNEWS plots increased to 12.1% in 1987, compared to 10.2% in 1986, 9.3% in 1985, and 8.3% in 1984.

In addition to the work on permanent plots, the results of observations for signs of possible acid rain damage were recorded for most of the 420 locations where detailed pest condition assessments were made. Special attention was directed to the number of years of needle retention on coniferous species. It is apparent that the percentage of needles retained decreases with the age of the foliage and the

rate of decrease varied among tree species and between provinces. At least some of the loss is definitely attributable to feeding by defoliating insects.

In 1985, in the southern part of New Brunswick, red spruce was found in a deteriorating condition at many locations on Deer Island, Charlotte County. Although trees in many of these areas have been defoliated by the spruce budworm in the past this does not adequately explain the condition observed. In 1986, permanent observation plots, each consisting of 50 trees, were established in Charlotte and Sunbury counties in New Brunswick and in Hants, Cumberland, and Halifax counties in Nova Scotia to follow changes in the condition of trees. The plot in Halifax County was cut in the summer of 1987. A summary of tree conditions in 1986 and 1987 at the remaining four plots is presented in Table 8. The trees were generally in better condition in 1987 than the previous year. Observations will continue.

unaffected trees. Some of the trees have thin crowns. The cause of this condition is unknown but no insects or diseases appear to be involved. Foliage, increment samples, and soil samples collected in the fall are awaiting analysis.

Québec

The 1985 report mentioned implementation of a network of permanent sample plots in national forests for monitoring stands, particularly with respect to reactions to air pollution. As part of this network, 25 plots were established in Québec by FIDS-LFC in the summers of 1984 and 1985.

The plots have been monitored and assessed each year as envisaged. Each site is visited in June in order to estimate weather-related damage and to examine the situation regarding foliage pests and diseases. Depending on whether

Table 8. Condition of red spruce at four permanent plots in the Maritimes in 1986 and 1987

		Per cent of trees in various tree condition classes							
		New Brunswick				Nova Scotia			
		Charlotte Co.		Sunbury Co. (a)		Hants Co.		Cumberland Co.	
	Tree Condition Class	86	87	86	87	86	87	86	87
1	Healthy, no defoliation	4	90	0	0	14	40	0	0
2	Healthy, only current defoliation	38	10	0	56	0	0	0	0
3	More than (2) less than 25% total defoliation	50	0	64	30	46	68	12	16
4	Total defoliation 26-50%, no bare top	6	0	28	10	36	2	74	82
5	Total defoliation 26-50% with bare top	2	0	8	0	4	0	14	2
11	More than 90% total defoliation with bare top	0	0	0	2	0	0	0	0

[a]One tree was blown down on the plot in Sunbury County, consequently the figures given total only 98% for this plot.

The deterioration of white birch along the Bay of Fundy was first noticed in 1978. The phenomenon has been under surveillance and has been reported annually in detail since 1979. In 1986, research was initiated to determine if 'acid rain' is a causal factor in the annually occurring foliage browning and early leaf fall in this area. In 1987, some leaf browning occurred again but it was at such low intensity that it could not be detected during aerial surveys.

Chlorotic foliage has been observed since 1935 on white spruce trees near Loch Katrine, Antigonish County, Nova Scotia in an uneven aged stand of about 20 ha. Although current foliage is green all older needles on affected trees exhibited various levels of yellowish discoloration. Not all trees in the stand are affected but trees from all age classes show similar symptoms. Yellowing is more prominent on the upper surface of needles than on the underside. Needle retention of older foliage is less in proportion than normally found on

stands contain hardwood trees, they are revisited in August and September for assessment and remeasurement. No deterioration visible to the eye has been observed in the stands examined. In 1987, plot No. 18 in Saint-Sylvestre was eliminated from the network because of major changes in the use of the land under study.

Leaf and soil samples have been taken from 15 plots, over the past three years and subjected to complete laboratory analyses. These baseline data will be compared with new data of the same kind collected every five years. Analysing five plots per year means that all 24 plots will have been studied by the end of a 5-year cycle.

Ontario

The Ontario FIDS Unit maintains 27 sample plots as part of the nationwide ARNEWS system.

The plots are established in strategic areas of various acid deposition zones; tree species in the plots reflect the major commercial species in the province. In 1987, all scheduled sampling was carried out in each plot while each was scrutinized for specific acid rain symptoms, and insect, disease, and abiotic damage. Nothing of any significance was found. In addition to the above, soil sampling was completed in each plot during the 1987 field season. Results of analysis of these samples will be published.

Prairie Provinces

Twelve permanent sampling plots, five in Alberta, three in Saskatchewan, and four in Manitoba, have now been established as part of a nationwide network of permanent plots to detect and monitor changes in forest soil, minor vegetation, and trees. Baseline data have been collected on tree growth, the present concentrations of foliar and soil elements, foliar and tree condition, and tree-damaging insect fauna and fungal disease organisms and their general level of abundance and damage. All ARNEWS plots were visited twice in 1987, once in June and again in late August, and were monitored for insect and disease damage. Increment core measurements of major sample trees were completed and all basic plot data were sent to the Petawawa National Forestry Institute for computer input and summary.

British Columbia

Since 1984, observations for fume or acid rain symptoms or damage which mimics that of acid rain have been made in British Columbia at 15 permanent plots (part of ARNEWS) and at more than 590 sample stations visited by FIDS rangers. About 20 tree species and numerous species of ground cover were generally healthy. Symptoms directly attributable to acid rain, including premature needle discoloration and loss of needles, have not been seen. Damage observed was usually attributable to previous or current pest conditions.

Two leaf spot fungi, causing marginal foliar browning and midseason leaf drop, were recorded for the first time in British Columbia. Vine maple in an acid rain study plot in North Vancouver were infected by *Septoria aceris* (Lib.) Berk & Br. and sitka alder in the West Kootenay were infected by *S. alnifolia* Ell. & Ev. Leaf loss was very light.

Older needles of mature western hemlock discoloured by sulphur dioxide emissions from a nearby pulp mill at Port Alice on Vancouver Island were less evident than in 1986. Interveinal discoloration of alder and salmonberry was very light over about 10 ha about 1 km east of the mill; conifer foliage was not usually affected. New shoots of hemlock appeared healthy.

Pests in young stands and plantations

Newfoundland

For the past several years population levels of the balsam wooly aphid *Adelges piceae* (Ratz.) have been increasing in natural and thinned stands in southwestern Newfoundland. In 1987, a cooperative project was initiated between the Newfoundland Forestry Centre and the Forest Pest Management Institute to test the potential use of insect growth regulators against the aphid. Four regulators were tested in field trials at Bottom Brook in western Newfoundland and the results are promising.

High numbers of the black army cutworm *Actebia fennica* (Tauscher) were found in four recently burnt areas planted with black spruce seedlings in central and western Newfoundland. The larvae first fed on a variety of herbaceous plants and then on hardwood and softwood regeneration. The highest population levels occurred in western Newfoundland where the cutworm had consumed all herbaceous vegetation and caused severe defoliation to planted seedlings. A control was applied in late June to protect the planted seedlings but had only little effect because many larvae had pupated.

Cutworm infestations usually develop in recently burned areas; therefore, it is recommended that no planting be conducted on burned over areas for at least two years after the burn. It is expected that the cutworm will infest these areas again in 1988.

The spruce bud scale *Physokermes piceae* (Schrank) was recorded for the first time in Newfoundland in 1986 in plantations in central Newfoundland. In 1987 population levels have increased in plantations near Springdale in central Newfoundland. Samples taken from these areas show a parasite present on many scales. All other plantations visited had low numbers of the bud scale.

Two infestations of the whitemarked tussock moth *Orgyia leucostigma* (J.E. Smith) continued for the second consecutive year in western Newfoundland. One of the infestations occurred near a plantation and was sprayed with a virus to reduce the threat to seedlings.

Low to medium population levels of the yellowheaded spruce sawfly *Pikonema alaskensis* (Roh.) caused light-to-moderate defoliation of black spruce in plantations near Grand Falls and in the Gander area. These insects usually feed in groups and can cause top mortality to immature trees.

Maritime Provinces

Forest pests can affect future wood supply and this fact resulted in New Brunswick's first large scale joint plantation survey, done by the provincial Department of Natural Resources and Energy (DNRE) in cooperation with the Forest Insect and Disease Survey of the Canadian Forestry Service-Maritimes in 1985, to assess the general state of health of plantations and of silviculturally treated (thinned) areas. The survey was conducted as a pilot project in anticipation of regular, continuing surveys in future years. In 1986, the Department of Natural Resources and Energy and (FIDS) were joined by two of New Brunswick's forest companies, J.D. Irving Ltd., and Fraser Inc., in carrying out extensive pest assessment surveys in plantations. To ensure uniformity and standardization, both field and classroom instruction courses were conducted in advance of the actual field work.

In 1987, the surveys were expanded and involved the above organizations and other forestry industries and provincial agencies in Nova Scotia and New Brunswick.

There were 193 plantations assessed by the various organizations, 149 in New Brunswick and 44 in Nova Scotia. The New Brunswick Department of Natural Resources and Energy also assessed 12 thinned areas. Observations were made on the type and the level of forest pest-caused disturbances or damage. Field assessments were carried out by staff of the various organizations. Identification of samples and summarizing were done by FIDS. Analysis of data is in progress and details will be reported. Involvement in organized pest surveys of this type being a new undertaking, some companies viewed 1987 as a pilot year and limited the number of assessments accordingly.

There were 303 assessments made in the 205 areas surveyed, 32% of the plantations or thinned areas having been visited twice during the season. A total of 14 500 trees were examined in the course of the surveys.

A brief summary of some of the observations in New Brunswick is presented here. Since no analysis is yet available on almost 70% of the plantations from Nova Scotia, comparative figures for that Province cannot be given here.

1. The most remarkable -- and comforting -- observation drawn from the results is that, in spite of the long list of organisms encountered, plantations of both spruce and pine were found to be generally in very good condition. An average of 93% of the trees examined in New Brunswick were classified as healthy.

2. In the thinned stands 99% of the trees were considered healthy.

3. Tree mortality was 1.2% for pine and 1.0% for spruce.

4. Current defoliation occurred on spruce in New Brunswick on 10% of the trees examined in DNRE Region 1 and 51% of the trees in DNRE Region 5. The intensity of defoliation was generally only trace. Moderate or severe defoliation occurred on less than 3% of the trees.

5. Current defoliation on pine was the highest in DNRE Region 2 (17%). The level of defoliation on the affected trees was generally light.

6. At least some damaged buds were present on 6% of spruce and 1% of pine trees.

7. Leaders were damaged on less than 5% of pine trees. On spruce, damaged leaders were observed on 9% of the trees.

8. Multiple leadering was more common on spruce and was reported on 22% of the trees. Nine per cent of the pine assessed had multiple leaders.

Spruce budmoths *Zeiraphera* spp.

The spruce budmoths *Zeiraphera canadensis* Mutuura & Freeman and, to a lesser degree, a closely related species *Zeiraphera unfortunana* Powell, have been omnipresent forest pests in the Maritimes since at least the late 1930s when the Forest Insect and Disease Survey started to keep records. Although widespread, insect populations have been generally low except for the occasional flare-up, usually on open-grown white spruce. The last recorded outbreak occurred in New Brunswick in the mid-1960s when spruce in parts of the Southwest Miramichi and the Nashwaak River drainage system sustained moderate-to-severe defoliation, and in Nova Scotia in the mid 1970s when similar levels of defoliation occurred in areas along the Northumberland Strait and the Fundy coast.

Spruce budmoth, which is not a significant pest in mature forests, became a major pest in 1980 when it was discovered to be causing defoliation, shoot distortion, and tree deformation in white spruce plantations over large areas in New Brunswick. In 1982, over two-thirds of the 180 locations surveyed in the Region were infested by spruce budmoth. At over 40% of these locations, in both New Brunswick and Prince Edward Island, defoliation and shoot damage were in excess of 10%. Injury was classed as moderate or severe at 10% and 20%, respectively, of the locations surveyed.

In 1987, spruce budmoths were widespread in the Region in white spruce plantations and, although the general level was similar to that in 1986, damage was considerable in some areas.

In New Brunswick, an average of 10% of the shoots of white spruce trees were affected at locations scattered around the Province. Shoot damage was 43% at St. Luc, Kent County in an old field, 29% at Belledune, Restigouche County, 27% on the Laverty Trail in Fundy National Park, 23% at Big Hole Brook, Restigouche County, 17% at Veneer, Victoria County, and 17% in a seed orchard at Pokiok Settlement, York County. Spruce budmoth damage was observed in 57% of the 12 white spruce plantations assessed for pest conditions in DNRE Region 5.

In Nova Scotia, an average of 9% of the white spruce shoots were damaged. The highest level of damage was recorded at MacNabs Cove, Cape Breton County where 55% of the shoots were damaged, and 49% shoot damage was observed at Belle Cote, Inverness County. At Ben Eoin, Cape Breton County, 43% of the shoots were damaged in 1987, compared to 35% in 1986.

In Prince Edward Island, an average of 15% of the white spruce shoots were damaged at the 12 locations assessed. Damage was highest at North Enmore, Prince County, where 72% of the shoots were affected by *Z. canadensis* on 80% of the trees while 21% shoot damage was caused by *Z. unfortunana* at Foxley River, Prince County. Other above average damage levels occurred at Hermanville, Kings County (25%) and at Primrose, Kings County (16%).

Control - In the third year of a developmental program towards control of the spruce budmoths, J.D. Irving Ltd. in cooperation with the CFS-Maritimes, sprayed 14 449 ha of white spruce plantations with fenitrothion (Sumithion®) which was applied at 105 g/ha in a total mix of 0.73 L/ha per application (an ULV formulation). Of the area 4714 ha received two applications and the remainder was treated once. Treatment coincided with adult emergence and results confirmed findings in 1985 and 1986 that, when applied at a suitable time, enough adult moths are killed to impact on egg laying. This significantly reduces damage the following year.

Pheromones were used in 1987 to time spraying operations, in monitoring the population levels, and in the first year of a 3-year study of mating disruption experiments.

(Note: *Z. unfortunana* is also referred to as the Purplestriped shootworm).

Seedling debarking weevil (*Hylobius congener*)

The seedling debarking weevil *Hylobius congener* D.T., Sch. & Marsh. has been suspected as the causal agent in the mortality of newly planted coniferous seedlings in central Nova Scotia since the beginning of the 1980s. Its association with the problem was first reported in 1984, when seedling mortality exceeded 85% in some plantations. The insect is present on sites as early as the time of harvest. Debarking of the stems of seedlings occurs from spring through to fall, resulting in progressively increasing seedling mortality. The amount of damage is related to forest management practices such as 'hot planting' (i.e. reforestation of cutover areas soon after harvest), site preparation, plantation size, and the proximity of plantations to other harvested areas. The level of concern for this insect is related to increased awareness by forest managers, the recognition of the fact that past unexplained plantation failures may have been the result of weevil damage and the realization that, in

the absence of practical control methods, the future of large scale plantation programs may be jeopardized.

In 1987, the weevil continued to damage and kill seedlings in recently established plantations, especially where planting had occurred within two field seasons of the harvesting operation. Damage levels were lower than in 1985 and 1986, apparently as a result of the extremely dry summer conditions which restricted weevil movement and feeding. However, significant damage still occurred on many sites, resulting in both poorly and unevenly stocked plantations. Some reforestation plans on softwood sites were postponed for 1987 because of anticipated weevil problems. The most severely affected areas remained eastern mainland Nova Scotia and eastern Prince Edward Island. Reports from New Brunswick were scattered and infrequent but significant mortality levels were encountered in Sunbury County (15%) and Kent County (21%) on black spruce.

Control - Most investigations during 1987 concentrated on measures to reduce damage. Various site preparation techniques, aimed at creating a barrier of mineral soil around seedlings, seemed to reduce damage, as did treatment of seedlings with an aerosol formulation of Tree Tanglefoot. Results will be published. Progress was also made in the search for a chemical control through the efforts of the Forest Pest Management Institute of the Canadian Forestry Service. Work by the Research and Productivity Council of New Brunswick, funded under the Canada/Nova Scotia Forest Resource Development Agreement, has resulted in a trap and lure system to be used for monitoring purposes, an essential ingredient in rating potential planting sites for hazard from the seedling debarking weevil.

Armillaria root rot

In New Brunswick, Armillaria root rot killed some trees in 22% of the 147 spruce and pine plantations surveyed. The 22% incidence of Armillaria-infected plantations is the same as was found in 1986 during a survey of 141 plantations but is 6% higher than in 1985, based on a survey of 70 plantations. The disease is present in all areas of the Province and affects both spruce and pine. There are differences in the rate of infection among the five regions and also between the levels to which the two species are affected (Table 9). Tree mortality in the affected plantations, attributable to Armillaria root rot, ranged from 2% to 16%. This figure is based only on trees definitely identified as infected by Armillaria root rot but in actuality may be higher if the cause of all dead trees were identified.

In addition to plantations detected during systematic surveys, other infected plantations were also found. In a 20 ha jack pine plantation at South Burnthill Brook, Carleton County, 24% of the trees were dead or dying in a single infection pocket while, in a 5 ha jack pine plantation at Clearwater Brook, Victoria County the affected trees were found in several widely spread infection pockets. Armillaria root rot was also found in a lodgepole pine plantation at West Branch Sabbies River, Northumberland County.

In natural stands, the following levels of infection by Armillaria root rot were noted: 44% of balsam fir affected near Pabineau Falls, Gloucester County, and at Cassilis, Northumberland County; 16% of balsam fir affected at Allainville, Northumberland County and near Glazier Lake, Madawaska County; 16% of trembling aspen affected at Smiths Corner, Kent County. Other infected stands were assessed in other parts of these counties and in Restigouche County.

In Nova Scotia, Armillaria root rot killed at least some trees in 17% of 12 spruce and pine plantations surveyed during the summer. In addition, 7% of the red spruce seedlings were dead or dying in a plantation north of Upper Mount Thom, Pictou County. Sugar maple trees were found infected at a location in Guysborough County and trembling aspen in Lunenburg County.

In Prince Edward Island plots established in plantations to study the spread of the disease on different hosts and under different conditions have been assessed annually since 1983. The plantations are of different ages and were established in areas of somewhat different cover types. Subplots, comprised of the 10 trees nearest all infected trees, have also been evaluated. Only the youngest plots were assessed in 1987 and some intensification was observed in all three plots. Trees in older plantations are said to acquire some resistance to fatal attack by Armillaria root rot, which resistance they retain as long as they are vigorous. They will be assessed on a 5-year cycle. More plots of various species and especially of younger ages need to be established to assess the real significance of this disease in plantations.

Table 9. Armillaria root rot in spruce and pine plantations in New Brunswick in 1987

Plantations/ Infection	Host	DNRE Resource Management Region				
		1	2	3	4	5
Number of plantations assessed	Spruce	11	8	16	9	69
	Pine	5	5	13	8	3
Per cent of infected plantations	Spruce	9	37	0	11	29
	Pine	0	20	0	12	0

DNRE = Department of Natural Resources and Environment

Sirococcus shoot blight *Sirococcus congenus*

Sirococcus shoot blight, caused by the fungus *Sirococcus conigenus* (DC) P. Cannon & Minter (previously known as *Sirococcus strobilinus* Preuss), has been known in the Maritimes since the early 1970s, but it is thought to have been present for much longer. The fungus infects and kills newly developed shoots. Heavy attacks cause branch mortality, which result in crown dieback and tree mortality. In the Maritimes, the disease affects red pine and occasionally spruce and larch, although other species of pine, hemlock, Douglas-fir, and true firs can also be affected. Trees of any size, from seedlings to 15 m in height, are damaged or killed.

The disease is present in all three provinces but is most widely distributed in red pine plantations in Nova Scotia, west of the Colchester-Pictou and Halifax-Guysborough county lines, and in natural regeneration in the southern half of New Brunswick.

In 1987, the disease further intensified in all three provinces. In many areas repeated infection has resulted in serious deterioration of red pine stands and plantations, sometimes to the point that salvage operations were carried out.

In New Brunswick, Sirococcus shoot blight occurs mostly in the southern part of the Province, although affected plantations are known as far north of the line from southern Victoria to northern Kent counties. Infection is severe on nearly all semi-mature red pine trees in a 2 ha plantation near Mechanic Settlement, Kings County; shoot damage was common on red pine trees in Fundy National Park, both near the Headquarters area and at the intersection of Herring Cove and Point Wolfe roads; young red pine trees were affected in a plantation at Big Forks, Kent County; and light shoot mortality occurred on red pine trees of all ages along the Shin Creek road in Sunbury County.

In Nova Scotia, infected red pine stands in Cumberland, Colchester, Hants, and Yarmouth counties continued to deteriorate. Some of the red pine plantations in the Rushy Lake area, Yarmouth County, are almost completely destroyed; infected plantations at Diligent River, and in the Chignecto Game Sanctuary in Cumberland County, continue to deteriorate and some were salvage cut in 1987; newly infected plantations were found at Southampton, Cumberland County, Eastville, Colchester County, and at Indian Falls, Melbourne County. At Indian Falls, a plantation had 68% of the trees infected, with an average of 17% of the shoots damaged. In addition to red pine, the disease was also identified on red spruce at East Wentworth, Cumberland County, on blue spruce at Weymouth, Digby County, on black spruce in a plantation at Mayfield, Antigonish County, and on white spruce cone scales from a seed orchard at East Mines Station, Colchester County.

The deterioration of pine stands by this disease in western Nova Scotia and the spread of the disease to plantations in the eastern half of the Province, where red pine has been a major plantation species in recent years, makes Sirococcus shoot blight one of the major plantation problems in Nova Scotia.

In Prince Edward Island, Sirococcus shoot blight is now known to be present at three locations: Goose River, Kings County, and Iona and Selkirk Road, Queens County. At Iona, where it was first reported on a few red pine trees in a 1 ha plantation in 1984, the number of infected shoots per tree have increased from 'light' to about 60% on some of the fringe trees in 1986. At Goose River, there was a marked increase in shoot infection in a 3 ha, 23-year old red pine plantation. First reported as light on a few trees in 1985, examination in 1986 showed that virtually all trees had some degree of damage, with about 5% of fringe and open growing trees having close to 50% shoot damage. At Selkirk Road, where the disease was observed for the first time in 1986, about 1% to 2% of the red pine supported from 5% to 29% damaged shoots on lower crown branches. Infection levels in 1987 remained about the same as in 1986 at all three locales.

Québec

A survey to determine the health of plantation trees was conducted from July 1 to September 4. Data from 858 plantations covered two different categories, i.e., spruce/fire trees (426) and pines (432). Thirty-seven of the plantations were given over exclusively to Christmas tree production. These plantations were located mainly in the Estrie (21) and Montreal (11) regions. They produced a total crop of 991 135 balsam firs and 98 700 Scots pines.

This year, data from the seed orchards were systematically excluded from the statistical processing aspect of the plantation monitoring program because the selection process applied in these orchards was not consistent with the strictly random selection approach required of all the projects included in the monitoring network. Assessment findings will be discussed in the last part of this section.

Insects - Damage due to the spruce budworm *Choristoneura fumiferana* (Clem.) in spruce plantations was not significant over the region as a whole. Only 7.3% of the trees were affected in 1987, down from the 1986 value of 14%. Furthermore, there was rarely more than trace damage and this occurred primarily in the of Bas-Saint-Laurent—Gaspésie and Côte-Nord administrative regions.

Spruce bud moth *Zeiraphera canadensis* Mut. and Free, populations had reached disturbing levels in 1986 in several white spruce plantations in the Bas-Saint-Laurent—Gaspésie region. This upsurge led to the implementation in 1987 of an experimental aerial chemical insecticide spraying program using a growth regulator. The program was carried out in 11 plantations with moderate-to-high spruce budmoth populations. These plantations were located near the municipalities of Saint-Alexis, Saint-Jean-de-Matapédia, and Saint-François-d'Assise. Because of problems related to larval behaviour and the concentrations of the product used, treatment thus far has failed to yield satisfactory results. The experiment will be resumed in the spring of 1988 so that the effectiveness of the proposed products may again be as-

sessed. Surveys conducted in 58 plantations in the Bas-Saint-Laurent—Gaspésie region in 1987 revealed that populations had generally remained stable in relation to 1986 levels. The spruce bud moth was detected in 88% of white spruce plantations, and leaders on over 32% of the planted white spruces in this region showed signs of spruce bud moth activity. A high population level was recorded in a large plantation near Lake Josué in the Baie des Chaleurs management unit, whereas moderate levels were observed in six plantations in Murdochville, Saint-Siméon-de-Bonaventure, Saint-Alphonse-de-Caplan, Sainte-Paule, Saint-François-d'-Assise, and Saint-André-de-Restigouche.

The white pine weevil, *Pissodes strobi* (Peck), occurred in one out of five spruce plantations throughout the nine administrative regions in Québec but affected an average of only 1% of trees. This pest was observed primarily in the Abitibi - Témiscamingue administrative region where it caused damage to 89% of spruce-fir plantations. In 1986, only 57% of these plantations were affected. Damage was observed in 2% to 5% of the spruce trees examined, whereas in 1986, the insect damaged 2% to 6% of the spruces. In plantations where recent damage fell in the moderate category, 1% of the trees examined were affected. The white pine weevil was active in the Outaouais region, where half of the plantations showed characteristic weevil damage in about 1% of the trees inspected. In the Trois-Rivières and Montréal regions, one out of three plantations displayed characteristic damage in 2% and 3% of examined trees, respectively. In the Estrie region, the white pine weevil affected one out of four plantations, as in 1986, but there was significantly greater insect activity, with the result that about 3% of the trees examined showed damage as opposed to 1.5% in 1986. In 3% of the damaged trees, however, insect activity occurred in plantations where damage was classified as light or trace. The white pine weevil was virtually absent from three administrative regions, i.e., Bas-Saint-Laurent—Gaspésie where only 5% of the plantations were affected, Saguenay—Lac-Saint-Jean with damage to 4% of the plantations, and the Côte-Nord which still shows no signs of insect activity.

In 1987, the European spruce sawfly *Gilpinia hercyniae* (Htg.) caused damage in nearly 18% of spruce-fir plantations scattered throughout the administrative regions whereas, in 1986, only 7% of the plantations were reported affected. An average larvae/tree count also indicated populations were rising. A similar count in 1981 recorded an average figure of 1.6 larvae per tree. As a result, the insect's activity was more closely monitored the following year. This year, the average count was 2.2 larvae/tree. In view of the insect's history, a special monitoring system is planned for 1988 to check the effectiveness of controlling populations by natural means using the viral disease that has been regulating European spruce sawfly populations for 40 years.

The redheaded pine sawfly *Neodiprion lecontei* (Fitch) has been more frequently observed in plantations this year. The insect, which occurs almost exclusively in the Montréal and Outaouais administrative regions, was detected in 21% and 28% of plantations, respectively, in 1987, whereas in 1986, it was found in only 9% and 17% of the plantations. The areas near Mont-Laurier, Notre-Dame-du-Laus, and Huntingdon will require monitoring in 1988 because defoliation is expected to exceed the threshold justifying introduction of insect control measures.

Diseases - All across the province, scleroderris canker *Gremmeniella abietina* (Lagerb.) Morelet remained the number one problem encountered in plantations. The disease affected young pines and occurred mainly on branches that were less than 2 m above the ground. In 1987, scleroderris canker was found in 20% of pine plantations, just as in 1986, and affected an average of nearly 4% of the trees. In 1986, the figure was 7%. At the regional level, the situation remained stable on the Côte-Nord region. The disease occurred in 62% of the plantations in the region, where it affected an average of 50% of the pines. In moderately and severely affected plantations, it was found in 40% and 10%, respectively, of the trees examined. In the Bas-Saint-Laurent—Gaspésie region, one out of three plantations harboured scleroderris canker, which affected 17% of the pines. In moderately and severely affected plantations, it attacked a total of 6% of the trees examined, compared to 13% in 1986. In the Outaouais region, where a number of pruning projects have been implemented over the past few years, only 7% of the plantations showed signs of the disease, which affected 6% of the trees. In plantations with trace and moderate levels of this canker, 4% and 2%, respectively, of the trees examined in this region were infected. In the Saguenay—Lac-Saint-Jean and Trois-Rivières administrative regions, scleroderris canker attacked 2% and 3%, respectively, of the trees, compared to 6% and 9% in 1986.

Although western gall rust *Endocronartium harknessii* (J.P. Moere) occurred in only a small number of trees, it was detected in one out of four plantations across the province whereas, in 1986, it was found in only one out of seven. The main regions involved were Saguenay—Lac-Saint-Jean (80% of plantations), Montréal (47% of plantations), and Côte-Nord (67% of plantations). As a rule, damage was minimal, ranging from trace to light.

Only 11% of plantations suffered from late frost and 5% of spruce-fir trees were damaged by this abiotic factor, compared to 40% in 1986. The Montréal, Abitibi - Témiscamingue, and Côte-Nord regions were the hardest hit with damage to 20%, 17%, and 19.6%, respectively, of spruce-fire trees. In the Montréal region, severe frost damage was recorded in only 10% of the trees examined.

Christmas Trees - Leaf rusts, spring frosts, and balsam twig aphids were the chief problems encountered in Christmas tree plantations. Leaf rusts, which include several pathogenic species (*Uredinopsis* spp., *Pucciniastrum* spp., *Melampsorella* spp.), were observed on over 60% of the 6600 balsam firs surveyed in the Estrie region. Damage ranged from trace to light and did not reduce the market value of the affected trees. There are few chemical treatments for these pathogens and treatment effectiveness is hard to check since the proliferation and development of these rusts depends on annual weather conditions. Frost damage to

shoots was less widespread this spring than last year, but it was occasionally observed in the Estrie and Montréal regions and fell in the trace-to-light categories. Ten Christmas tree plantations were attacked by balsam twig aphids (*Mindarus abietinus* Koch) causing light to heavy damage. In a 3000-fir tree plantation close to the municipality of Lac-Drolet, insect or damage levels were estimated as high (over 25% of the trees exhibited over 25% shoot damage). Only one pathogenic agent, western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka, was occasionally found on Scots pine trees. Generally, this leaf rust does not result in economic losses and it can be eliminated by a simple mechanical treatment.

Ontario

Conifer plantation surveys focused on white spruce in 1987. This survey is part of a continuing program to investigate and gather data on insect, disease, and abiotic agents affecting conifer plantations in the province. A total of 12 300 trees were examined in 82 plantations. Two visits were made to each plantation in order to accommodate the feeding period of the major pests expected to be encountered in the survey. A total of 150 trees was scrutinized in each plantation on each visit with the following results.

Insects - The most important insect was the spruce budworm *Choristoneura fumiferana* Clem. which was found on 2099 trees or 17% of the total. The most heavily infested plantations were in the Northwestern and North Central Regions, areas where the curent budworm and spruce conworm averaged 9% on infested trees but ranged as high as 85% in the more heavily infested stands. Defoliation by the two insects is combined because they often feed together and it is not possible to distinguish damage between them.

The second most abundant insects were the spruce budmoths *Zeiraphera* spp. which were recorded in 1103 trees or 9% of the total. It was recovered in 30 of the 82 plantations with the highest populations in Patton and Wells townships, Blind River District where 100% of the trees were infested.

The yellowheaded spruce sawfly *Pikonema alaskensis* Roh. was present in 21 plantations, affecting 246 trees or 2% of the total. The insect caused an average of 6% defoliation on infested trees with the highest average defoliation (18%) recorded in Digby Township, Minden District.

The spruce coneworm *Dioryctria reniculelloides* Mut. & Mun. was recovered from 94 trees or less than 1% of the total, most of which were located in the Geraldton and Nipigon districts. Defoliation by this species and the spruce budworm averaged 8% as described above. The only other insect of any significance was the white pine weevil *Pissodes strobi* Peck which attacked 39 trees, less than 1% of the total. It was found in 13 plantations, all but three of which were in northern Ontario. A number of other insects were collected in the course of the survey, none of which caused any appreciable damage. These included the European spruce sawfly *Gilpinia hercyniae* (Htg.), the eastern spruce gall adelgid *Adelges abietis* (Linn.), the balsam fir sawfly *Neodiprion abietis* complex, and the spruce gall adelgid *Adelges lariciatus* (Patch).

Diseases - On the whole, very little disease damage was found in the survey. The needle rusts, *Chrysomyxa ledi* Lagh., were the most common. Needle rust was found on 1292 trees, 10% of the total, most of which were in southern Ontario. While the incidence of these diseases was high in some areas, actual foliage damage, with a few exceptions, was in the 1% to 5% range. These exceptions were in single plantations in the Kirkland Lake, Terrace Bay, and Sudbury districts where foliage damage was 12%, 13%, and 30%, respectively.

Armillaria root rot, *Armillaria mellea* (Vahl:Fr.) Kummer, was found on 14 trees and foliage chlorosis of unknown cause was found on 97 trees. Twenty-six trees were killed by unknown agents.

Abiotic factors - Frost damage was the most widespread damaging agent encountered in the survey. A total of 4309 trees or 35% of the total were affected. The damage was widespread throughout the province but was most prevalent and most damaging in the North Central and Northwestern Regions where many plantations had 100% of the trees affected.

Prairie Provinces

A committee, with representation from the three Prairie Provinces and Canadian Forestry Service, was established in early 1987 to develop a standardized field survey method suitable for conducting pest surveys in high value conifer stands within the region. The method provides a means to systematically sample and quantitatively assess plantations and naturally regenerated areas for incidence of tree mortality, stem deformities, and reduced growth. Plantations sampled in 1987, including seven in Manitoba, two in Saskatchewan, and 15 in Alberta provided a trial run to test out the survey method and gave an indication of some important pest problems.

In Manitoba, the most important factors causing mortality included Armillaria root rot, pine root-collar weevils, and western gall rust. In Saskatchewan, Armillaria root rot was also present but at a lower incidence level in the plantations sampled. Damage by Armillaria root rot was often associated with "J"-root formation, indicating an interaction with improper planting procedures. In Alberta, tree mortality resulted from Armillaria root rot (up to 14% incidence), comandra blister rust, Warren's root-collar weevil (*Hylobius warreni* Wood), and western gall rust.

British Columbia

New infestations of black army cutworm *Actebia fennica* (Tausch) severely defoliated conifer seedlings and herbaceous ground cover and delayed planting in 2-year-old burns in the East Kootenay and Kamloops regions. Popula-

tions declined in previously infested areas of the Prince Rupert, Prince George, and Cariboo regions.

Spruce and pine seedlings, planted in late 1986, and patches of ground cover over an estimated 1000 ha were severely defoliated in parts of the 1985 "Ram" Fire east of Canal Flats in the Nelson Region. Planting in the nearby "Giby" Fire was delayed until larval feeding, which severely defoliated patches of ground cover over about 900 ha, was concluded. Small numbers of larvae occurred in the nearby "Black" Fire and at Marl Creek north of Golden. However, neither larvae nor feeding damage was observed in several other recent burns in the East and West Kootenay.

About 10% of the newly planted Douglas-fir seedlings in a 2-year-old burn near Salmon Arm were moderately to severely defoliated by greatly increased cutworm larval populations. Most herbaceous ground cover on ridge tops and west-facing slopes on about 5% of the 80-ha area were totally defoliated. On a 150-ha site near Vavenby, burned in 1984, larvae destroyed half the foliage on 10% of the Douglas-fir seedlings. All ground cover in six patches on west facing slopes and ridge tops was totally stripped and up to 20 late-instar larvae were counted in 1000 cm^2 duff samples.

In the eastern part of the Prince Rupert Region cutworm were at their lowest levels in recent years. Fewer than three larvae per 1000 cm^2 duff sample, no seedling damage, and only minimal feeding on ground cover were evident in burned sites near Smithers Landing and Chapman Lake.

Populations of black army cutworm north of Prince George collapsed following several years of high numbers and damage. There was also little evidence of cutworm larvae in the Cariboo Region, where populations were common, but damage was minimal in 1986. Very low numbers of larvae were seen for the first time in a 1986 burn east of Quesnel, but there was no feeding damage to the Douglas-fir and white spruce seedlings or to ground cover. Larvae were not found at several other sites burned in 1986 in the northeastern part of the region, where pheromone-baited sticky traps attracted 10 or more male adults last year.

Parasitism of cutworm larvae and pupae averaged 22% and 37%, respectively, in the Prince Rupert, Prince George, and Cariboo regions in 1986. This contributed to the population decline, along with predation by voles and birds and virus infection. Larval and pupal parasitism in new infestations in the Nelson Region averaged 2.3%, too low to reduce populations in 1988. However, near Vavenby in the Kamloops Region parasitism approached 50%.

Sticky and multipher traps baited with experimental pheromones attracted up to 64 male moths per trap at 43 sites in four regions. Continuing populations are therefore forecast for parts of the Nelson and Kamloops regions, but cutworm populations should remain low elsewhere.

Rhizina root disease *Rhizina undulata* Fr. was abundant in several cutblocks north of Hazelton in the Prince Rupert Region. There was no damage on spruce and pine seedlings planted this year. This fire related disease was first observed affecting conifer seedlings in British Columbia in 1967 and in the Prince Rupert Region in 1968. Damage was usually prevalent in the first year after the burn, reduced slightly in the second year, and disappeared in the third year.

As predicted, populations of the variegated cutworm, *Peridroma saucia* (Hbn.), which occurred for the first time in high numbers in 1986 in the eastern part of the Cariboo Region, were not present on the site in 1987. Some spruce seedlings and ground cover over part of the plantation had been severely defoliated. Overwintering mortality of pupae was 77%, 64% died during the winter, predation killed 11%, and 2% were parasitized. Pheromone-baited sticky traps at two recently burned sites nearby attracted an average of one to five moths, probably too few to sustain a potentially damaging larval population.

In other surveys of pests of young stands, damage by about 35 currently active pests was identified on 12 conifer hosts in 62 young stands (60% planted, 40% natural) in five forest regions. Most common was Cooley spruce gall adelgid *Adelges cooleyi* (Gill.) which lightly infested new growth of three spruce hosts and Douglas-fir in 20 stands. Pine stem and branch rusts were also found. Western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hirat. infected an average 11% of the lodgepole pine in 17 stands. *Cronartium* species were on 11% of the lodgepole pine in nine stands in the Prince George Region,and white pine blister rust *C. ribicola* J.C. Fisch. killed or infected 21% of the white pine in three stands in the Nelson and Vancouver regions. Warren's root collar weevil *Hylobius warreni* Wood killed an average of 4% of the young lodgepole pine in three plantations in the Prince George Region.

Sclerophoma semenospora Funk and *S. pithyophila* (Cord.) Hoehn., a dieback disease of Douglas-fir which usually follows drought, frost damage, and other injuries, infected up to 20% of 10- to 12-year-old Douglas-fir in three plantations in the Cariboo Region, causing dieback of 35 cm to 1 m. Most of the Douglas-fir in 1982 plantations southwest of Stuart Lake in the Prince George Region and near McLeod Lake were poorly formed with multiple tops, dead leaders, and lateral branches which was attributed to infection by *S. pithyophila*.

Infection by *Atropellis piniphila* (Weir) Lohman & Cash in young stands at Opatcho Lake in the Prince George Region was 29% in non-spaced areas but less than 1% in spaced areas. Western gall rust was more common, infecting 40% of the trees in spaced stands and 34% in non-spaced stands. In natural stands near Tumbler Ridge and in the Yukon Territory the rust infected up to 25% of the regeneration lodgepole pine. Comandra and stalactiform blister rusts infected only 1% of the young lodgepole pine in four stands north of Prince George and at four locations in the Yukon Territory.

The incidence of leader mortality in immature lodgepole pine stands caused by *Pissodes terminalis* Hopping, in the western part of the Cariboo Region, declined to 7% from

about 16% in 1986. There was a significant reduction in broods in the eastern part of the Prince Rupert Region. Although leaders attacked in 1986 were dead, 70% did not contain broods even though egg-laying niches were evident. Near Ootsa Lake, 90% of the early-instar larvae were dead.

Mortality of recently planted conifer seedlings suspected to be caused by high numbers of meadow voles *Microtus* sp. increased significantly in the eastern part of the Prince Rupert Region. Feeding was more common but less severe in poorly and nonburned sites than in burned sites. The greatest vole damage of the eight plantations examined was west of Burns Lake, where 37% of the 1986 planted lodgepole pine and 16% of the white spruce were killed and another 24% damaged.

Up to 45% of the young pine in three of 15 conifer plantations near Ootsa and Maxan Lakes were severely girdled near the base, possibly by hares. An additional 50% of the trees were lightly debarked. Patches of bark on the stems and branches of conifers in young and semimature stands were chewed by porcupines in the western part of the Prince Rupert Region. Patchy, scattered mortality is an increasing problem. A small program of reintroduction of fishers which prey on porcupines is underway.

Other Insects, Disease, and Damage

Newfoundland

Insects, Disease, or Damage	Host(s)	Location	Remarks
Abiotic damage Atmospheric impurities	White pine	Nova Scotia	Crowns of white pine were thin and off-colour near a tin mine at East Kemptville, Yarmouth County.
Frost damage	Balsam fir Black spruce White spruce Pin cherry	Avalon Peninsula Western Labrador	On the Avalon Peninsula severe frost damage to the shoots of ornamental white spruce. In western Labrador 80% damage to scattered balsam fir saplings occurred along the Fermont Road, and 20% damage occurred to black spruce saplings in a 1 ha area.
Ice and snowstorm damage	Softwood and hardwood species	Avalon Peninsula	Weight of ice and snow caused outer twigs and branches to break.
Wind damage	Urban trees	Western Newfoundland	Trees 15 metres high blown over by 140 kilometre per hour winds in city of Corner Brook.
Anthracnose *Kabatiella apocrypta* (Ell. & Ev.) Arx	Red maple	Western Newfoundland	Low incidence. 20% of foliage affected on few samplings.
Balsam fir sawfly *Neodiprion abietis* complex	Balsam fir	Western and eastern Newfoundland	Populations low throughout the region.
Balsam twig aphid *Mindarus abietinus* Koch.	Balsam fir	Western and eastern Newfoundland Western Labrador	Low to moderate populations. Infestations of new shoots ranged from 10% to 60%.
Birch casebearer *Coleophora serratella* (L.)	White birch Speckled alder	Throughout Newfoundland	Populations and leaf browning light to moderate throughout, except for few severely damaged areas in eastern Newfoundland.
Birch leafminer *Fenusa pusilla* (Lep.)	White birch Trembling aspen	Western and eastern Newfoundland Labrador	Low to moderate numbers. Damage ranged from trace to severe.
Black Knot *Apiosporina morbosa* (Schw.) Arx	Plum Cherry	Throughout Newfoundland	Low incidence to ornamentals on the Avalon Peninsula. Common on pin cherry throughout the Island.
Broom rust *Melampsorella caryophyllacearum* Schroet.	Balsam fir	Western Newfoundland Avalon Peninsula	Low incidence. 10% of the trees infected in an area on the Avalon Peninsula.
Cytospora canker and dieback *Cytospora chrysosperma* (Pers.) Fr.	Willow Pin cherry	Avalon Peninsula	Moderate incidence. 100% of the willow trees in a 2 ha area affected.
Eastern blackheaded budworm *Acleris variana* (Fern.)	Black spruce White spruce Balsam fir	Throughout Newfoundland	Low populations.
European alder leafminer *Fenusa dohrnii* (Tischb.)	Speckled alder	Western Newfoundland Labrador	Low populations. Light to moderate browning.
European poplar canker *Dothichiza populea* Sacc. & Briard	Lombardy poplar	Western Newfoundland Avalon Peninsula	High incidence. 100% infection resulted in up to 80% of the branches affected. Mortality also occurred on some smaller trees.
European spruce sawfly *Gilpinia hercyaiae* (Htg.)	Black spruce White spruce Sitka spruce	Western and central Newfoundland Western Labrador	Low populations. No significant damage.

Newfoundland, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Fall webworm *Hyphantria cunea* (Drury)	Speckled alder	Western Newfoundland	Nests were very common throughout the Black Duck-Stephenville area.
Green balsam looper *Cladara limitaria* (Wlk.)	Balsam fir White spruce	Western and eastern Newfoundland	Low numbers. No significant defoliation.
Larch sawfly *Pristiphora erichsonii* Htg.	Tamarack	Western and eastern Newfoundland Western Labrador	Low numbers and light defoliation in western Newfoundland. High populations and severe defoliation in eastern Newfoundland. High populations in western Labrador, but only trace defoliation, due to late larval emergence.
Leaf blister *Taphrina poulina* Fr.	Hybrid poplar Lombardy poplar	Central Newfoundland Avalon Peninsula	Up to 30% of the foliage affected on ornamentals.
Leaf rust *Melampsora abieti-capraearum* Tub.	Willows	Western and eastern Newfoundland Western Labrador	Varying levels of infection scattered throughout the region.
Leaf and shoot blight *Pollacia elegans* Serv.	Hybrid poplar Balsam poplar	Avalon Peninsula	Low incidence. Up to 80% of the foliage affected on one balsam poplar tree at St. John's.
Venturia macularis (Fr.) Mull. & Arx	Trembling aspen	Western and eastern Newfoundland Eastern Labrador	Moderate incidence recorded in western Newfoundland. Low incidence elsewhere.
Leaf spot and canker *Septoria musiva* Peck.	Balsam poplar	Western Newfoundland	100% of the trees infected and 5% dead in Crabbes River Provincial Park. Dieback from the tops is also very characteristic.
Mountain-ash sawfly *Pristiphora geniculata* (Htg.)	American mountain-ash	Western and eastern Newfoundland Western Labrador	Moderate to severe defoliation on fa few trees in western Newfoundland.
Needle cast *Isthmiella crepidiformis* (Darker) Darker	Black spruce	Central Newfoundland	Low incidence. Only a few trees affected.
Lirula nervata (Darker) Darker	Balsam fir	Eastern Labrador	Moderate damage on a few trees.
Lophodermium pinastri (Schrad. ex Fr.) Chev.	Eastern white pine Jack pine	Central Newfoundland Avalon Peninsula	High incidence. 80% of the foliage affected in a jack pine plantation on the Avalon Peninsula.
Needle rust *Pucciniastrum epilobii* Otth	Balsam fir	Central Newfoundland Western Labrador	High incidence. Severe damage to few trees in central Newfoundland and to a 1 hectare stand in Western Labrador.
Phomopsis blight *Phomopsis juniperovora* Hahn.	Northern white cedar	Avalon Peninsula	Up to 100% of the cedars infected, with up to 50% of the foliage affected in urban areas of St. John's.
Poplar serpentine leafminer *Phyllocnistis populiella* Cham.	Trembling aspen Balsam poplar	Western and central Newfoundland Eastern Labrador	Populations varied from low to high. 10-20% damage recorded throughout the areas.
Red flag *Fusicoccum abietinum* (Hartig) Prill. & Del.	Balsam fir	Western Labrador	Moderate incidence. Common throughout the area.

Newfoundland, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Shot hole *Coccomyces hiemalis* Higgins	Pin cherry	Avalon Peninsula	Low incidence.
Sirococcus shoot blight *Sirococcus strobilinus* Preuss	White spruce	Central Newfoundland	All samples examined from a tree nursery were affected. Pycnidia were very abundant. A new host record.
Striped alder sawfly *Hemichroa crocea* (Geoff.)	Speckled alder White birch	Western Newfoundland Labrador	Populations ranged from low to high. In western Newfoundland defoliation varied from a trace to 100%. High numbers were recorded in Labrador, but only 20% defoliation occurred due to late larval emergence.
Taphrina witch's broom *Taphrina cerasi* (Fckl.) Sadeb.	Pin cherry	Avalon Peninsula	Low incidence. Up to three brooms affecting 20% of one tree.
Tar spot *Rhytisma salicinum* (Pers.) Fr.	Willows	Labrador	Low to moderate incidence. Up to 40% affected. Common throughout.
White pine blister rust *Cronartium ribicola* J.C. Fischer	Eastern white pine	Throughout Newfoundland	In central Newfoundland pine trees are dead or dying due to blister rust infection in certain areas.
Willow blight *Fusicladium saliciperdum* (All. & Tub.) Lind.	Willows	Eastern Newfoundland	Up to 60% of laurel leaf willow affected. High mortality to golden willows.
Physalospora miyabeana Fukushi	Willows	Eastern Newfoundland	Up to 60% of laurel leaf willow affected. High mortality to golden willows.
Willow leaf beetle *Chrysomela falsa* Brown	Willow Balsam poplar	Eastern Newfoundland Eastern Labrador	Severe defoliation (up to 90%) was recorded on both species in a square kilometre area near Otter Creek in eastern Labrador. Light defoliation elsewhere.
Yellow leaf blister *Taphrina populina* Fr.	Hybrid poplar	Central and eastern Newfoundland	Low incidence. 30% of the foliage affected on ornamentals in St. John's.
Yellowheaded spruce sawfly *Pikonema alaskensis* (Roh.)	Black spruce	Central and eastern Newfoundland Eastern Labrador	Low populations. 30% current defoliation recorded on few trees in a plantation in central Newfoundland. Defoliation ranged from trace to 10% elsewhere.
Dieback	White birch Maple	New Brunswick Nova Scotia	White birch mortality at Red Martin Head, St. John County, New Brunswick (ARNEWS Plot 206) was 28%, and 44% of the trees had upper crown branch mortality. In Nova Scotia, crown dieback of red maple ranged from 50 to 90% at Oak Park, Shelburne County and the same degree of crown damage occurred on red maple and white birch at Beaver River, Yarmouth County.
Discoloured and mottled foliage	Conifers Hardwoods	New Brunswick Nova Scotia	Various amounts of foliage discolouration of several coniferous and deciduous species. Cause unknown but probably varies by location and species. Tree species affected in New Brunswick: black spruce in Restigouche County, red spruce in Westmorland County, white birch in Gloucester,

Newfoundland, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
			Northumberland, Kent, and Sunbury counties, yellow birch in St. John County, beech in York County. In Nova Scotia balsam fir in Inverness and Guysborough counties, red spruce in Richmond County, white birch in Inverness County.

Maritimes Region

Insects, Disease, or Damage	Host(s)	Location	Remarks
Abiotic damage Drought	Conifers Hardwoods	New Brunswick Nova Scotia	Premature yellowing of white and wire birch in southern New Brunswick and also of speckled alder in much of the Province. At some locations as much as 75% of white birch and 64% of wire birch leaves turned yellow prematurely. Drought conditions were similar but more widespread in Nova Scotia and affected a broad range of hosts.
Flooding	Conifers Hardwoods	New Brunswick	Spring flooding on the Saint John River damaged, uprooted, and destroyed trees between Perth and Hartland, Carleton County; McGowans Corner, Sunbury County, and Jemseg, Queens County.
Frost	Conifers Hardwoods	New Brunswick Nova Scotia	In New Brunswick, moderate shoot damage to balsam fir at two locations in Restigouche County (48% and 36% shoot damage), light or trace on various conifers in Kent, Kings, Queens, York, Madawaska, and Northumberland counties. In Nova Scotia, moderate damage to white spruce in Lunenburg County, light or trace elsewhere in all but Digby and Annapolis Counties.
Hail	Balsam fir Jack pine Cedar	New Brunswick	Moderate damage over approximately 25 hectares near North Branch Burnt Hill Brook, Carleton County.
Ocean salt spray	White pine	Nova Scotia	Moderate damage to white pine near Digby, Digby County.
Red shoots	Balsam fir	New Brunswick Nova Scotia	Red flagging of unknown cause in Madawaska, York and Westmorland counties, New Brunswick and Halifax County, Nova Scotia. As much as 25% of balsam fir trees affected in Northumberland County, New Brunswick and 88% in Halifax County (ARNEWS Plot 214), Nova Scotia.
Roadside salt damage	Conifers	Maritime Province	Severe or moderate discoloration on roadside white pine throughout much of New Brunswick; 40% of balsam fir affected at Tweedie, Carleton County. In Nova Scotia, discoloration of red and white pine severe, moderate, or light in the eastern half of the Province, only light or trace in the western half. Damage to 80% of white spruce at French Lake, Inverness County in Cape Breton Highlands National Park. Severe damage to red and Scots pine in Kings County, Prince Edward Island.
Snow damage	Balsam fir Jack pine Red pine	Maritime Provinces	In New Brunswick, snow broke branches on 16% of jack pine trees at Kouchibouguac National Park, Kent County; damage also in Northumberland, Victoria, and York counties. In Nova Scotia, damage on 56% of balsam fir at MacMillan Flowage, Victoria County, 52% of red pine east of Judique, Inverness County; damage also on balsam fir in Inverness County. In Prince Edward Island, damage to 44% of red pine at North Granville, Queens County.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Wind damage	Hardwoods Conifers	Maritime Provinces	Strong winds blew down urban hardwood trees and caused property damage in Charlottetown, Prince Edward Island and Truro, Nova Scotia. Blowdown affected 44% of black spruce trees near St. Luc, Kent County and caused light damage in balsam fir and red spruce stands in Victoria and York counties, New Brunswick; branch damage to 80% of white birch trees near Otter Brook, Sunbury County, New Brunswick; severe and moderate foliage damage of various hardwoods in Gloucester, Northumberland and York counties, New Brunswick and Cape Breton County, Nova Scotia.
Winter drying	Conifers	Maritime Provinces	Foliage browning widespread in New Brunswick with Scots pine affected more frequently than any other species. Severe, moderate, and light browning of Scots pine occurred throughout; severe and moderate browning of cedar occurred from Victoria to Charlotte County; and moderate browning of balsam fir observed in St. John, York, and Victoria counties. In Nova Scotia, foliage browning widespread in the eastern part of the Province at various intensities. In western Nova Scotia, 50-70% of balsam fir trees affected in Yarmouth and Digby counties. In Prince Edward Island, browning severe throughout on red pine and occurred on jack pine and Scots pine in Prince County.
Alder flea beetle *Altica ambiens alni* Harr.	Alder	Maritime Provinces	Patches of severe and moderate browning in Charlotte, York, Queens, Sunbury, and Carleton counties, New Brunswick. Browning in western New Brunswick did not extend as far north as in 1986. In Nova Scotia, numerous patches of severe and moderate browning in Victoria, Antigonish, Pictou, Halifax, central Colchester, and Hants counties, and as far southwest as Queens County. In Prince Edward Island no damage in Queens and Kings counties where small patches of severe browning occurred in 1986.
Ambermarked birch leafminer *Profenusa thomsoni* Konow	White birch Wire birch	Nova Scotia Prince Edward Island	In Nova Scotia low populations light or trace in Kings, Cumberland, Lunenburg, Queens, and Pictou counties, with a high of 16% of white birch leaves affected at Grand Lake, Annapolis County. Highest population at Milford, Annapolis County, where 32% of wire birch leaves affected. In Prince Edward Island National Park at Dalvay, 31% of wire birch leaves, but only 4% of white birch leaves, affected.
Animal damage Deer	Jack pine Norway spruce	New Brunswick	Damage by deer observed on jack pine in Victoria and Albert counties and on Norway spruce in York County.
Porcupine	Balsam fir Jack pine Red pine White pine	Nova Scotia New Brunswick	Damage common throughout New Brunswick and Nova Scotia. Damage ranged from 4 to 18% of five hosts in 10 New Brunswick counties; and from 4 to 44% in affected pine plantations

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
	Tamarack Red spruce		in Hants, Pictou, Shelburne, and Queens counties in Nova Scotia.
Rabbit	Conifers	Maritime Provinces	Damage to 13% of white pine trees at Little Wapski Brook, Victoria County, New Brunswick. In Nova Scotia, moderate damage (36% of shoots) on 80% of white spruce trees in a stand in Victoria County; light and trace damage elsewhere in the Province. In Prince Edward Island, heavy damage on Norway spruce in a plantation in Kings County.
Squirrel	Jack pine Red pine	New Brunswick	Shoot damage and cone removal observed at various locations. Damage low, highest (at 9% shoot damage) on jack pine in Carleton County.
Anthracnose of maple *Kabatiella apocrypta* (Ell. and Ev.) Arx	Red maple Sugar maple	Maritime Provinces	In New Brunswick, moderate browning of red maple in small areas in Kent and Queens counties, and of sugar maple in York County. Present elsewhere but only at trace levels. In Nova Scotia, found on sugar maple in Colchester and Halifax counties. Not seen in Prince Edward Island.
Ants *Formicidae*	Conifers	New Brunswick Prince Edward Island	Present in newly-established plantations in and near the root systems of all newly planted trees at very high populations in Kings County, Prince Edward Island. Bark of ornamentals damaged in a yard in Gloucester County, New Brunswick.
Ash yellows	Ash	Maritime Provinces	Not found in the Region to date. This disease is present in the United States and is a concern for plant quarantine officials.
Aspen leafrollers *Epinotia criddleana* (Kft.) *Pseudexentera oregonana* (Wlshm.) Darkheaded aspen leafroller *Anacampsis innocuella* (Zell.) Lightheaded aspen leafroller *Anacampsis niveopulvella* (Cham.) Spotted aspen leafroller *Pseudosciaphila duplex* (Wlshm.)	Aspen	Maritime Provinces	Leafrollers, mostly of trembling aspen, common throughout the Region but restricted mainly to trace and light levels. The most serious leafrolling observed at Aylesford, Kings County, Nova Scotia where all trees were affected and 64% of the leaves were rolled.
Aspen webworm *Tetralopha aplastella* (Hlst.) and Lesser aspen webworm *Meroptera pravella* (Grt.)	Trembling aspen	Maritime Provinces	Not found in 1987. Collapse of populations *related to decline of forest tent caterpillar* populations.
Bagworm *Thyridopteryx ephemaraeformis* (Haw.)	Spruce	Nova Scotia	Found in beating samples at seven locations.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Balsam bark weevil *Pissodes dubius* Rand.	Balsam fir Black spruce Red spruce White spruce	Maritime Provinces	In New Brunswick, common on dead and dying balsam fir and to a lesser extent on spruces (red, black, white). About 7% of balsam fir affected at 25 locations in nine counties. In Nova Scotia, an average of 12% of balsam fir affected in Cape Breton, Richmond, and Victoria counties. In Prince Edward Island, 33% of red and white spruce trees affected at Dalvay and Melville, Queens County.
Balsam fir bark beetle *Pityokteines sparsus* (Lec.)	Balsam fir	New Brunswick Nova Scotia	Present in many weakened balsam fir trees throughout most of New Brunswick. Highest infestations found at Cassilis, Northumberland County (48%) and on Pabineau Falls Road, Gloucester County (40%). In Nova Scotia, 8% of trees infested in a stand in Cape Breton County.
Balsam fir sawfly *Neodiprion abietis* (Harr.)	Balsam fir Black spruce Red spruce White spruce	Maritime Provinces	Present in low numbers at a few locations scattered throughout the Region. More common in Nova Scotia.
Balsam shootboring sawfly *Pleroneura brunneicornis* Roh.	Balsam fir	New Brunswick Nova Scotia	In New Brunswick, an average of 8% of shoots infested at nine scattered locations. In Nova Scotia, 1% of the shoots infested at one location in Queens County, out of 16 areas checked in the Province.
Beech bark disease *Nectria coccinea* var. *faginata Lohm.*, Wats. Beech scale *Cryptococcus fagisuga* Lind.	Beech	Maritime Provinces	Cankered trees remain common throughout the Region. Average of cankered trees was 98% in New Brunswick (four locations) and 86% in Nova Scotia (range 68-100% at 10 locations).
Birch sawfly *Arge pectoralis* (Leach)	White birch	New Brunswick Nova Scotia	Found at Beaverbrook Road, Northumberland County, New Brunswick, and East Lake Ainslie, Inverness County, Nova Scotia.
Black leaf blister *Taphrina dearnessii* Jenkins	Red maple	New Brunswick Nova Scotia	In New Brunswick, moderate (32%) infection in two areas in Northumberland County, in Nova Scotia light infection at several locations.
Bruce spanworm *Operophtera bruceata* (Hist.)	Trembling aspen	Nova Scotia	Found only at one location in the Region, in Cumberland County, Nova Scotia, in 1987.
Canker of larch *Potebniamyces coniferarum* (Hahn) Smerlis	Tamarack	New Brunswick	Found at two locations each in New Brunswick and Nova Scotia.
Cedar leafminers *Argyresthia aureoargentella* Brower *Argyresthia freyella* Wishm. *Coleotechnites thujaella* (Kft.)	Cedar	New Brunswick Prince Edward Island	In Prince Edward Island, infestations in potato plants persisted in parts of Prince County in the same areas and at the same levels as in the past years between Wellington and Miscouche South. Chronic attack in the Muddy Creek area caused further tree deterioration and mortality. In New Brunswick, an average of 16% of the trees affected at 11 locations in Charlotte, Gloucester, Madawaska, St. John, and York counties.
Cherry blight	Pin cherry Choke cherry	Maritime Provinces	Present at varying levels of intensity throughout much of the Region. More common than in previous years in parts of New Brunswick.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Cherry casebearer *Coleophera pruniella* Clem.	Trembling aspen	Nova Scotia	Light browning at Wallace, Cumberland County.
Condition of spruce	White spruce	New Brunswick	Continued deterioration of mature spruce trees in the Robinsonville, Dawsonville, and Glenlevit areas of Restigouche County likely due to a combination of several secondary organisms.
Conifer aphids *Cinara* spp. *Cinara nigra* (Wilson) *C. ontarioensis* Bradley *C. nigripes* Bradley *C. obscura* Bradley	Balsam fir	Maritime Provinces	Common throughout the Region, sometimes affecting the majority of trees in localized situations, but causing little damage. A first report for *Cinara nigra* from Hampton Corner, York County. *C. ontarioensis* from New Scotland, Westmorland County, both on jack pine, *C. nigripes* on black spruce at West Sabbies River, Northumberland County and *C. obscura* on spruce at Blue Mountain, Restigouche County, New Brunswick.
Deterioration of cedar	Cedar	New Brunswick	Condition of cedar trees in Charlotte and St. John counties improved in 1987. Thin crowns were still evident; damage by cedar leafminer and brown cedar leafminer was trace or light. Initial cause of the deterioration remains uncertain.
Diplodia tip blight *Sphaeropsis sapinea* (Fr.) Dyko & Sutton	Red pine Scots pine	Nova Scotia	Present on ornamental trees in Halifax, Yarmouth, and Lunenburg counties.
Eastern blackheaded budworm *Acleris variana* (Fern.)	Balsam fir	Maritime Provinces	Very low numbers throughout the Region.
Eastern dwarf mistletoe *Arceuthobium pusillum* Peck	Spruce	Maritime Provinces	Low levels in the Region.
Eastern spruce gall adelgid *Adelges abietis* (L.)	Red spruce White spruce Norway spruce	Maritime Provinces	Throughout, generally at trace to light infestation levels. Highest infestations in 1987 were 36% in New Brunswick, 37% in Nova Scotia, and 11% in Prince Edward Island.
Eastern tent caterpillar *Malacosoma americanum* (F.)	Apple Cherry	Maritime Provinces	Populations generally low, although more common than in previous years in many areas of New Brunswick, especially in the southern part of the Province. Nests in only one area of Prince Edward Island.
Elm leaf aphid *Tinocallis ulmifolii* (Monell)	Elm	New Brunswick	Populations very high at Fredericton, York County, where cars and streets were covered with a layer of honeydew that tended to collect dust and dirt.
Elm leaf beetle *Pyrrhalta luteola* (Mull.)	Elm	New Brunswick	Low levels at Fredericton, York County.
Elm leafminer *Fenusa ulmi* Sund.	English elm Rock elm	Maritime Provinces	Present at various intensity levels throughout, wherever exotic elms are present. Severe leaf browning common in all three Provinces.
European pine sawfly *Neodiprion sertifer* (Geoff.)	Austrian pine Mugho pine	New Brunswick Nova Scotia	Present on ornamentals in low numbers.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
European pine shoot moth *Rhyacionia buoliana* (D.&S.)	Red pine Jack pine	Maritime Provinces	Populations low throughout Region, except at North Granville, Queens County, Prince Edward Island, where 59% of shoots were damaged in a red pine plantation.
European spruce sawfly *Gilpinia hercyniae* (Htg.)	Spruce	Maritime Provinces	Populations remained low throughout the Region and decreased sharply at the permanent plots at the Acadia Forest Experiment Station, Sunbury Co., New Brunswick
Fall cankerworm *Alsophila pometaria* (Harr.)	Hardwoods	Maritime Provinces	All outbreaks collapsed in the Region, and populations were low throughout. One solitary maple tree had light to moderate defoliation at Nash Creek, Restigouche County, New Brunswick.
Fall webworm *Hyphantria cunea* (Dru.)	Deciduous	Maritime Provinces	In Nova Scotia, nests common again on roadside bushes in the western half of the Province and scattered nests noted elsewhere. In New Brunswick, a single nest was noted in Kouchibouguac National Park. In Prince Edward Island, scattered nests were present throughout Prince County.
Fir coneworm *Dioryctria abietivorella* (Grt.)	Conifers	New Brunswick Nova Scotia	Few larvae at two locations in New Brunswick and one in Nova Scotia.
Flat leaftier *Psilcorsis reflexella* Clem.	Trembling aspen Largetooth aspen White birch Red oak	Maritime Provinces	Common in western Nova Scotia, as much as 85% of red oak foliage affected in a stand in Shelburne County. Present at a few locations in New Brunswick. Not seen in Prince Edward Island.
Forest tent caterpillar *Malacosoma disstria* Hbn.	Hardwoods	Maritime Provinces	Populations very low throughout and expected to remain so in 1988 as indicated by light trap catches and pheromone surveys. Damage of trembling aspen, resulting from the recent outbreak, is widespread. The only population of note was present in the Granton area, Pictou County, Nova Scotia.
Four-eyed spruce bark beetle *Polygraphus rufipennis* (Kby.)	Black spruce Red spruce White spruce	New Brunswick	Found at nine locations scattered throughout New Brunswick, with an average of 8% of trees affected. Highest incidence (16%) in Sunbury County, New Brunswick and at Dalvay, Queens County in the Prince Edward Island National Park.
Western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka	Jack pine Lodgepole pine	New Brunswick	Common in many areas of New Brunswick both in plantations and natural stands. As much as 56% of trees affected in some jack pine plantations.
Greenheaded spruce sawfly *Pikonema dimmockii* (Cress.)	Spruce	New Brunswick Nova Scotia	Populations very low.
Greenstriped mapleworm *Dryocampa rubicunda rubicunda* (F.)	Red maple	Maritime Provinces	Populations very low, found only in Digby, Pictou, and Shelburne counties in Nova Scotia.
Ink spot of aspen *Ciborinia whetzelii* (Seaver)	Trembling aspen	Maritime Provinces	Generally low levels. Light infection at a few locations.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Jack pine budworm *Choristoneura pinus pinus* Free.	Jack pine	Maritime Provinces	Declined to endemic levels throughout the Region.
Larch sawfly *Pristiphora erichsonii* (Htg.)	Tamarack	Maritime Provinces	Defoliation severe or moderate on a few roadside trees in Kings County, moderate or light in Charlotte County and light on an ornamental tree in Fredericton, York County, New Brunswick; moderate or light on a few roadside trees in Cumberland County, Nova Scotia; moderate on a few small trees in Prince County, Prince Edward Island.
Large aspen tortrix *Choristoneura conflictana* (Wlk.)	Trembling aspen Wire birch	Maritime Provinces	Leafrolling at low levels at scattered locations, except in two areas of Pictou County, Nova Scotia where light to moderate leaf rolling occurred on about 100 ha. Forest tent caterpillar was also involved in the Granton area of Pictou County.
Larch needleworm *Zeiraphera improbana* (Wlk.)	Tamarack	Nova Scotia	Found at four widely scattered locations in mainland Nova Scotia at trace level.
Leaf blister *Taphrina carnea* Johanson	Birch	New Brunswick	Light infection at most sample points.
Leaf blotch of horsechestnut *Guignardia aesculi* (Peck.) V.W. Stew.	Horsechestnut	Maritime Provinces	Foliage browning dramatically reduced from previous years. In New Brunswick leaf browning in light in Charlotte County and other areas where the host is present. In Nova Scotia moderate and light browning in Hants and scattered areas of Pictou and Kings counties.
Leaf and twig blight of aspen *Venturia macularis* (Fr.) Muell. & Arx	Largetooth aspen Trembling aspen	Maritime Provinces	Common throughout the Region. Leaf and shoot damage averaged 9% on half the trees in New Brunswick (21 locations, highest 32%) and 21% on 62% of trees in Nova Scotia (23 locations, highest 76%). Present in all three counties in Prince Edward Island but damage no higher than light at any location.
Leaf rollers on birch *Caloptilia* sp.	White birch Wire birch Yellow birch	New Brunswick	Widely distributed throughout New Brunswick and Nova Scotia. Leaf rolling at trace level on 73% of trees in New Brunswick (42 locations) and on 33% of trees in Nova Scotia.
Leaf spot of poplar *Drepanopeziza tremulae* Rimpau	Trembling aspen	Nova Scotia	Browning of all leaves on every tree at West St. Andrews, Colchester County and 36% of leaves on all trees at White Rock, Kings County.
Lesser maple spanworm *Itame pustularia* (Gn.)	Red maple	Maritime Provinces	Populations very low throughout. Even the highest light trap catch (314 moths) in the Region in Kejimkujik National Park, Nova Scotia was the lowest in more than 10 years at that location.
Maple leafroller *Sparganothis acerivorana* Mack.	Red maple Sugar maple	Maritime Provinces	In Prince Edward Island, general decrease in populations, except for severe leafrolling of red maple over 10 ha near Central Bedeque, Prince County and moderate at Stanhope, Queens County. In New Brunswick populations generally light except for moderate leafrolling of sugar maple at Astle, York County. In Nova Scotia populations remained very low.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Mites *Nalepella halourga* Keifer	Black spruce White spruce	New Brunswick	A first report for this eriophyid mite, found on black spruce at Grindstone Brook, Victoria County and Wildcat Brook, Restigouche County. It appears to be responsible for needle stippling but its damage potential is unclear. Also present on white spruce clone bank at Acadia Forest Experiment Station, Sunbury County causing reddening and stippling of foliage.
Oligonychus milleri (McGregor)	Jack pine Red pine	Maritime Provinces	Mite populations, at levels damaging to pines, collapsed throughout the Region except for a few pockets in jack pine plantations in Victoria and York counties, New Brunswick and Prince County, Prince Edward Island. In Nova Scotia, the mite infestation on red pine in the Trafalgar burn area on the eastern mainland collapsed and plantations appear much healthier with the loss of older damaged foliage.
Oligonychus ununguis (Jacobi)	Red spruce	New Brunswick	Trace discolouration by the spruce spider mite in York County.
Trisetacus distinctum Smith	Cedar	New Brunswick	A first report for this eriophyid mite, from Upper Hainesville, York County. Its damage potential is unknown.
Mountain ash sawfly *Pristiphora geniculata* (Htg.)	Mountain ash	Maritime Provinces	Severe or moderate defoliation of ornamentals at scattered locations in York County, New Brunswick, Colchester and Cape Breton counties, Nova Scotia and Kings County, Prince Edward Island. Light defoliation elsewhere.
Needle casts *Lirula macrospora* (Hartig) Darker	Spruce	New Brunswick Nova Scotia	Moderate needle infection in Fundy National Park in New Brunswick. Common in Nova Scotia but infections light.
Davisomycella ampla (Davis) Darker	Jack pine	New Brunswick	Trace-to-light infection on a few trees in Kings County, New Brunswick.
Lirula nervata (Darker) Darker	Balsam fir	New Brunswick Nova Scotia	Various levels of intensity at a few locations in New Brunswick and Nova Scotia. More common in Nova Scotia.
Northern cedar bark beetle *Phloeosinus canadensis* Sw.	Cedar	New Brunswick	Red flagging of 88% of shoots at South Knowlesville, 49% at Armond, and 23% at Hale, Carleton County. 35% of shoots affected in an area in Restigouche County. Shoot damage also in other areas of Carleton and York counties.
Northern pitch twig moth *Petrova albicapitana* (Busck)	Jack pine Scots pine	Maritime Provinces	In New Brunswick, widespread in jack pine plantations with as much as 54% of the trees affected along the Big Eskedellac River in Northumberland and Gloucester counties. In Nova Scotia, nodules present on 84% of the trees near Est Apple River, Cumberland County. Also observed in Pictou County. Found in one plantation in Prince Edward Island.
Oblique-banded leafroller *Choristoneura rosaceana* (Harr.)	Siberian pea Trembling aspen White birch	Maritime Provinces	Present in very low numbers.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Orange-humped mapleworm *Symmerista leucitys* Francl.	Beech Sugar maple	Nova Scotia	Endemic levels.
Pepper-and-salt moth *Biston betularia cognataria* (Gn.)	Mountain ash Manitoba maple	Nova Scotia Prince Edward Island	Trace defoliation only at one location each in both Nova Scotia and Prince Edward Island.
Pine bark adelgid *Pineus strobi* (Htg.)	Pine	Maritime Provinces	Widely distributed and common. Infestations generally low occasionally at light intensity.
Pinkstriped oakworm *Anisota virginiensis virginiensis* (Drury)	Red oak	Maritime Provinces	Few larvae at one location in Nova Scotia.
Poplar leaf-folding sawfly *Phyllocolpa* sp.	Trembling aspen Largetooth aspen	Maritime Provinces	On trembling aspen an average of 13% of leaves affected in New Brunswick (36 locations), 14% in Nova Scotia (32 locations), and 8% in Prince Edward Island (8 locations). The number of trees affected averaged 77%, 88%, and 55% for the three provinces, respectively. Largetooth aspen was infested in Charlotte County, New Brunswick and Pictou County, Nova Scotia. Infestation levels were light (24% and 11%, respectively).
Poplar leafmining sawfly *Messa populifoliella* (Town.)	Carolina poplar Trembling aspen	New Brunswick Nova Scotia	Leaf mining of ornamental Carolina poplar moderate and severe at Fredericton, York County and light in York and Victoria counties, New Brunswick. Leaf mining on trembling aspen trace in Pictou, Colchester, and Digby counties, Nova Scotia.
Poplar petiolegall moth *Ectoedemia populella* Busck	Trembling aspen	Nova Scotia	Present in some areas in the eastern part of the province, infesting up to 27% of leaf petioles on most trees at Maryvale, Antigonish County.
Premature needle loss	Black spruce	New Brunswick	The premature loss of the previous year's foliage reported from Victoria and Madawaska counties in 1986 continued in 1987. This year approximately 1000 ha of high value plantations suffered light to severe loss of 1986 needles. At two severely affected locations about 75% of 1986 foliage complement was lost. The cause of the needle loss remains unexplained.
Ragged spruce gall adelgid *Pineus similis* (Gill.)	Red spruce	Maritime Provinces	Scattered locations throughout the Region at low levels. Most common in Nova Scotia.
Redheaded jack pine sawfly *Neodiprion virginiana* complex	Jack pine Scots pine	Nova Scotia	Noticeable defoliation on ornamental Scots pine at Springville, Pictou County. Also found in a jack pine plantation near Shulie Lake, Comberland County.
Red pine cone beetle *Conophthorus resinosae* Hopk.	Red pine	New Brunswick	A few shoots infested at Sussex, Kings County.
Red spruce adelgid *Pineus floccus*	Black spruce Red spruce	New Brunswick Nova Scotia	In New Brunswick, a few galls present on scattered trees in plantations and natural stands in York, Kent, Northumberland, Gloucester, Restigouche, and Madawaska counties; up to half the red spruce affected in a young stand in

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
			Northumberland County. In Nova Scotia, up to 40% of red spruce affected in a stand in Digby County and galls were found on red spruce in a few widely scattered areas in Lunenburg and Queens counties.
Resin flow	White spruce	Prince Edward Island	Scars in bark and pitch flow common on underside of branches in areas of southern Kings County. Bark is not missing but there are numerous spots of pitch on the underside of branches.
Satin moth *Leucoma salicis* (L.)	Carolina poplar Silver poplar Trembling aspen Willow	Maritime Provinces	In New Brunswick, severe defoliation on Carolina poplar at New Maryland, York County, moderate defoliation on ornamental willows and poplars at Janeville, Gloucester County. No noticeable defoliation of trembling aspen in the Popple Depot, Northumberland County, area where severe defoliation occurred in 1986. In Nova Scotia, no noticeable defoliation. In Prince Edward Island, defoliation severe on ornamental poplars at Wellington, Prince County, moderate on a few trees at Royalty, Queens County and light at St. Peter, Kings County.
Saddled prominent *Heterocampa guttivitta* (Wlk.)	Sugar maple	Maritime Provinces	Endemic levels in the Region.
Spring cankerworm *Paleacrita vernata* (Peck)	Elm	Nova Scotia	Endemic levels.
Spruce bud midge *Rhabdophaga swainei* Felt	Black spruce Red spruce White spruce	Maritime Provinces	Populations low but widespread throughout. No more than 8% of buds infested anywhere in the Region.
Spruce bud scale *Physokermes piceae* (Schr.)	Black spruce Red spruce White spruce	Maritime Provinces	Present in plantations, natural forests, and on ornamentals throughout Nova Scotia and scattered locations in New Brunswick and Prince Edward Island. More than 35% of branches of most black spruce infested in areas of Inverness and Digby counties, more than 23% of nearly all red spruce infested in several areas in Digby County, Nova Scotia. Moderate infestation of white spruce at Stanhope, Queens County, Prince Edward Island. In New Brunswick, infestations generally at trace level, except light in a white spruce plantation in Kent County.
Spruce coneworm *Dioryctria reniculelloides* Mut. & Mun.	Spruce	Maritime Provinces	Populations remained low (one larva collected at each of four locations).
Spruce cone maggot *Hylemya anthracina* (Czerny)	Black spruce Red spruce White spruce	Maritime Provinces	Present at low levels in New Brunswick and Nova Scotia.
Spruce gall adelgid *Adelges lariciatus*	White spruce Red spruce Larch	Maritime Provinces	Present in low numbers. Trace damage at scattered locations throughout the Region.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Spruce spittlebug *Aphrophora parallela* (Say)	Red spruce	Nova Scotia	Found at Annapolis Royal, Annapolis County.
Spittlebugs *Sphrophora* sp.	Balsam fir Jack pine Red pine Tamarack White pine White spruce	Nova Scotia Prince Edward Island	Recorded from scattered areas of Colchester, Halifax, and Queens counties, Nova Scotia, and from Kings and Prince counties, Prince Edward Island.
Cercopidae sp.	Balsam fir White birch Yellow birch	Nova Scotia	Present on 40% of white birch trees in an area of Cape Breton County, on 26% of shoots of half the balsam fir trees in Inverness County, and in low numbers on yellow birch in Colchester County.
Striped alder sawfly *Hemichroa crocea* (Geoff.)	Alder	Maritime Provinces	Populations are low throughout the Region. Only trace defoliation at Grand Harbour, Charlotte County, New Brunswick where defoliation was severe in 1986.
Sugar maple borer *Glycobius speciosus* (Say)	Sugar maple	Maritime Provinces	Throughout most of New Brunswick. In Nova Scotia 18% of the trees infested at Island Lake, Guysborough County, a few trees near Economy, Colchester County and 20% of trees affected near Kellys Cross, Queens County, Prince Edward Island.
Sulphur dioxide damage	Conifers Hardwoods	New Brunswick	Condition of the various tree species continued to deteriorate and some mortality of conifers occurred in a plantation near a base metal smelter in Gloucester County.
Sweetfern blister rust *Cronartium comptoniae* Arth.	Lodgepole pine	New Brunswick	Present and probably causing tree mortality in a small plantation at Nevers Brook, Kent County and near West Branch Sabbies River, Northumberland County.
Tar spot of maple *Phytisma acerinum* (Pers. ex St. Amans) Fr.	Maple	New Brunswick Nova Scotia	Found at scattered locations in New Brunswick and Nova Scotia with an average of almost 25% of the leaves affected. As much as 88% of the leaves infected in an area in southwestern Nova Scotia.
Tip blight of balsam fir *Delphinella balsameae* (Waterm.) E. Muell.	Balsam fir	Maritime Provinces	Not found in 1987.
Uglynest caterpillar *Archips cerasivorana* (Fitch)	Cherry Poplar Willow	Maritime Provinces	Populations increased dramatically. Found at numerous scattered locations throughout, and especially common on roadside bushes in Hants and Antigonish counties, Nova Scotia. Nests as many as 32/100 m^2 recorded in Madawaska County, New Brunswick, 50/100 m^2 in Prince County, and 100/100 m^2 at Morrell, Kings County, Prince Edward Island.
Wax filament scale *Xylococculus betulae* (Perg.)	Beech White birch	Maritime Provinces	Infestations on white birch severe and moderate at five locations, light at five other locations in New Brunswick. In Nova Scotia, infestations severe and moderate on white birch at five locations,

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
			light on beech at one location. In Prince Edward Island, light infestation on scattered white birch trees in the National Park.
White pine blister rust *Cronartium ribicola* J.C. Fisch.	White pine	Maritime Provinces	Throughout the Region. In 1987 it was recorded on 28%, 16%, and 12% of young trees at locations in Restigouche, Northumberland, and Kent counties, New Brunswick, respectively, and on 8% of the trees in an area in Pictou County, Nova Scotia. Observed but not assessed at other scattered locations.
White pine cone beetle *Conophthorus coniperda* (Sz.)	Red pine White pine	New Brunswick Nova Scotia	Attacks the base of second year cones, causing them to shrivel and drop. Cone damage occurred in a red pine plantation at Kempt, Queens County, in a natural white pine stand near River Hebert, Cumberland County, Nova Scotia, and on an ornamental white pine at Fredericton, New Brunswick.
White pine needle blight	White pine	Maritime Provinces	Not reported in 1987.
White pine sawfly *Neodiprion pinetum* Nort.	White pine	Nova Scotia	Populations increased at widespread locations. Moderate and light defoliation of a few roadside trees in the Chignecto Game Sanctuary, Cumberland County, of ornamentals at Parrsboro, Cumberland County, and near Five Islands, Colchester County. Numerous larvae at a location each in Cape Breton and in Halifax counties.
White pine weevil *Pissodes strobi* (Htg.)	Jack pine Scots pine White pine Black spruce Norway spruce Red spruce White spruce	New Brunswick Nova Scotia	Present in plantations and on ornamentals throughout the Region, often causing considerable damage. Selected infestation levels to illustrate extent of damage: 75% of Norway spruce at Kirkland, Carleton County; 40% of white pine at St. Luc, Kent County; 36% of white pine at Semiwagon Ridge, Northumberland County, New Brunswick; 24% of white pine at Garden of Eden Barrens, Guysborough County; 16% of white pine at Indian Fields, Shelburne County, Nova Scotia.
Whitespotted sawyer beetle *Monochamus scutellatus* (Say)	Balsam fir Red spruce White spruce Jack pine	Maritime Provinces	Red flagging of balsam fir caused by adult feeding on the underside of small branches common in western and northern New Brunswick, in Pictou County, N.S. and scattered throughout the Musquodoboit Valley in Nova Scotia. Sawyer beetles were present in many of the trees that succumbed to the Stillwell's Syndrome (see text). In New Brunswick an average of 13% of balsam fir trees were infested at 19 locations examined. The insect is a factor on the deterioration of fire killed jack pine in northeastern New Brunswick. In Prince Edward Island, 67% of the red spruce and 20% of the white spruce trees were infested in a stand in Queens County.
Willow blight *Venturia saliciperda* Nuesch	Willow	Maritime Provinces	Foliage browning present but at the lowest levels in years in the Region. In western Nova Scotia, where the reduction was most significant, hedgerows and individual trees are in poor

Maritimes Region, cont.

Insects, Disease, or Damage	Host	Location	Remarks
			condition in parts of Kings County as a result of repeated severe willow blight during past years.
Willow flea weevil *Rhynchaenus rufipes* (Lec.)	Trembling aspen Willow	Maritime Provinces	Severe and moderate browning of ornamental willows and, to a lesser extent, trembling aspen, in much of eastern New Brunswick, throughout eastern Nova Scotia, in western Prince Edward Island, and at scattered locations elsewhere in the Region.
Winter moth *Operophtera brumata* (L.)	Deciduous	Nova Scotia	Not collected in 1987.
Yellowheaded spruce sawfly *Pikonema alaskensis* (Roh.)	Black spruce Red spruce White spruce	Maritime Provinces	Low populations found at nine locations in New Brunswick and 20 locations in Nova Scotia. Moderate defoliation of ornamental spruce in Westmorland County, New Brunswick. In Prince Edward Island, moderate defoliation of scattered black spruce trees near Mt. Carmel, Prince County. Only light defoliation in the two black spruce plantations at Dromore, Queens County and at Peakes, Kings County where defoliation was severe in 1986.
Yellow witch's broom on spruce *Chrysomyxa arctostaphyli* Diet.	Red spruce	Nova Scotia	Present on scattered red spruce trees in Shelburne and Yarmouth counties.

Québec Region

Insects, Disease, or Damage	Host(s)	Location	Remarks
Abiotic damage Blowdown	Hardwoods Softwoods	Kinnears Mills (Beauce)	This tornado, which occurred on July 26, knocked down trees over a 17-ha area.
Spring frosts	Trembling aspen	Beauce, Bas-Saint-Laurent, and Charlevoix	In natural forests, the trembling aspen was the species most often damaged by spring frosts.
	Spruce, fir, larch	Montréal South, Eastern Townships, Charlevoix, and Côte-Nord	In plantations, most of the damage fell in the trace or light categories. Only one plantation producing white spruce was severely affected. It was located near Lac Pérodeau.
			In general, frost damage in the province was less severe in 1987 than in 1986.
Aspen serpentine leafminer *Phyllocnistis populiella* (Cham.)	Trembling aspen Balsam poplar	Basins of the Matane and Matapédia rivers as well as north and east of Lake Matapédia	Light infestation in the first basin, moderate-to-high in the second and moderate near Lake Matapédia.
		Along the Grande Cascapédia, Petite Cascapédia Est et Ouest, and Bonaventure rivers	Infestations remained stationary at a moderate level.
		Basins of the York and Sainte-Anne rivers	Moderate infestation which became light near the basins of the Saint-Jean and Darmouth rivers and of the Cap-Chat and Grands Méchins rivers.
		Basins of the l'Anse Pleureuse, Mont-Louis, Grosses Roches, and Matane rivers	New sites with light infestation.
		Lake Parent and Lake Ruth (Saguenay)	High intensity of attack.
		Basins of the aux Outardes, Manicouagan, and Toulnustouc rivers (Saguenay)	Infestation covered the same areas as in 1986 but damage was more severe.
Aspen skeletonizer *Phratora purpurea purpurea* Brown	Trembling aspen	Saint-Barnabé (Saint-Maurice)	Severe defoliation.
		Mékinac River, along Highway 155 between the Matawin Crossing and Grandes-Piles	50% of foliage affected.
Balsam fir sawfly *Neodiprion abietis* (Harr.)	Balsam fir	Northwest of Red Mill (Champlain)	Trace damage to trees.
		Along Highways 105 and 309 (Papineau)	Drop in populations.
		Ottawa River	Stationary.
Balsam Woolly aphid *Adelges picea* (Ratz).	Balsam fir	Cap-des-Rosiers, Port-Daniel (Bonaventure)	Trace damage in both localities.

Québec Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Beech bark disease *Nectria cocinea* var. *faginata* Lohm. Wats. & Ayers *Nectria galligena* Bres	American beech	Pointe-à-la-Garde (Bonaventure), Luskville (Pontiac) *Mont Eléphant, Glen Sutton* (2 sites), Saint-Denis and Brome (Brome)	In 1987, beech bark disease was detected in 10 new sites, eight of which were in southeastern Quebec. Among the new sites, two exhibited high *levels of infestation and were located at* Pointe-à-la-Garde and Mont Eléphant, respectively.
		Mont-Carmel (Kamouraska) Saint-Victor and Saint-Ephrem (Beauce)	Sites with high levels of damage.
Birch leafminer *Fenusa pusilla* (Lep.)	White birch	D'Alembert and Saint-Joseph-de-Cléricy (Abitibi)	Very common insect. 20% to 50% damage to foliage.
Birch casebearer *Coleophora serratella* (L.)	White birch	Northeast of Saint-Noël (Matapédia)	Light damage.
		South of aux Eclairs River (north of Portneuf Reserve)	Reduced severity of attack; light defoliation compared to severe damage inflicted in 1986.
		Lake Wayagamac, La Tuque	Moderate damage at the fringe of these two areas.
		Croche River and Trenche River (Champlain)	Severe damage.
Birch leafminer		Lake Savane (Mont-Tremblant Park)	Trees blown down over a distance of 15 km on July 24.
Brownheaded jack pine sawfly *Neodiprion dubiosus* Schedl Redheaded jack pine sawfly *Neodiprion rugifrons* Midd.	Jack pine	Several localities in the province, particularly in the Rivière-du-Loup, Charlevoix-est, Champlain, and Témiscamingue districts	Present in trace numbers.
Diplodia blight *Sphaeropsis sapinea* (Fr.) Dyko & Sutton	Red pine	Otter Lake (Pontiac)	Virtually all over the tops of dominant red pines. Disease uncommon in Québec but well established in Ontario and New Brunswick.
Dutch elm disease *Ceratocystis ulmi* (Buism.) C. Moreau	White elm	Rivière-du-Moulin Nature Reserve (Lotbinière)	Moderate damage on 50% of the trees.
		Aux Trembles Island on the Ashuapmuchuan River (Lac-Saint-Jean-ouest)	New site, moderate damage.
		Saint-Félicien (Lac-Saint-Jean-ouest)	In 1987, mortality of young trees in this site which was discovered in 1985.
		Saint-Pacôme (Kamouraska)	65% of the elms were severely affected.
		New Richmond (Bonaventure)	Site with a high degree of damage.
European snout beetle *Phyllobius oblongus* (L.)	Sugar maple	Saint-Sébastien, Lambton, La Guadeloupe (Beauce)	Large adult population. Regeneration affected.
Godronia blight *Godronia cassandrae* PK.	Yellow birch	Tantaré Nature Reserve (Montmorency)	Blight observed on young yellow birches.

Québec Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
	White birch	Lake Garant (Montmorency)	Mortality of 50 regeneration white birches.
Ink spot *Ciborinia whetzelii* (Seaver) Seaver	Trembling aspen	Saint-Fidèle (Charlevoix-est) and Amos	The only two areas in the province. Disease was found at moderate levels.
Jack pine sawfly *Neodiprion pratti-banksianae* Roh.	Jack pine	Along Highway 40, between Champlain and Cap-de-la-Madeleine	Stationary site of infestation.
		Lake Tousignant (Matawin Township)	Extension of infestation noted in the Normand and Livernois Townships in 1986.
		La Vérendrye Reserve Kazabazua (Lower Lièvre)	Present. Stationary site of infestation.
	Pitch pine	St-Antoine-Abbé (Châteauguay)	Trace infestation in the pitch pine nature reserve.
Larch sawfly *Pristiphora erichsonii* (Htg.)	Tamarack	Northeast of Saint-Edgar (Bonaventure)	Presence of the insect in a seed stand.
		North of New Carlisle	Trace damage in a mature stand.
		Southwest of the Gagnon Depot (Bonaventure)	Light defoliation on young trees.
Leaf spot disease *Septoria* sp.	White birch	Lake Gros (Gaspé-est) north of Montréal, and Lièvre River	The pathogen caused overall foliar damage on white birches, at times affecting wide areas. When the infestation was severe, trees lost their foliage prematurely.
	Sugar maple Red maple	Beauce, Portneuf, and Appalachian Mountains	Detected chiefly on regeneration growth and young maples in many maple stands.
Needle casts *Lirula mirabilis* (Darker) Darker	Balsam fir	Lake Morin (Rimouski) Lake Valois (Laurentides Wildlife Reserve)	Reddening of the needles, uncommon. Detected this year in natural forests. It may affect up to 75% of the foliage on one given tree.
Naemacyclus sp.	Scots pine	Saint-Paulin-Dalibaire (Matane)	Plantation with an estimated foliar loss of over 50%.
Oak leafshredder *Croesia semipurpurana* (Kft.)	Red oak	Beaupré, Orléans Island	Decline in population compared to last year.
Orangehumped mapleworm *Symmerista leucitys* Franc.	Sugar maple	St-Basile-de-Portneuf	Disappeared.
		(Beauce)	Present at non-significant levels.
Pine needleminer *Exoteleia pinifoliella* (Cham.)	Jack pine	Lorrainville (Témiscamingue) and Magog (Stanstead)	High incidence of attack in both localities.
Poplar leafminer *Lyonetia* sp.	Trembling aspen Balsam poplar	Lake Parent and Lake Ruth (Saguenay)	Occupied same areas infested with the aspen serpentine leafminer.

Québec Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
		East of the Manic 5 dam (Saguenay)	Moderate infestation. Aspen serpentine leafminer also present.
Red pine sawfly *Neodiprion nanulus nanulus* Schedl	Jack pine	East of Gilardo dam (Saint Maurice)	Trace population.
	Red pine	Saint-Antoine-Abbé (Châteauguay)	Insect still present this year in the pitch pine nature reserve.
Root rot *Cylindrocarpon destructans* (Zinssm.) Scholten	Jack pine	Sainte-Jeanne-d'Arc (Lac-Saint-Jean-ouest)	In one plantation this fungus was associated with the death of 50% of the seedlings planted in June 1987.
Spruce beetle *Dendroctonus rufipennis* (Kby.)	White spruce	Brick River, McDonald River, à la Patate River, Lac Wickenden (Anticosti Island)	Active populations found in 1987.
Tar spot *Rhytisma punctatum* Fr.	Mountain maple	Restigouche Nature Reserve (Bonaventure)	The disease was found on the foliage of 100% of the mountain maples.
White pine blister rust *Cronartium ribicola* J.C. Fisher	White pine	Lac Nazaire (Saguenay)	First record.
Yellowheaded spruce sawfly *Pikonema alaskensis* (Roh.)	White spruce	aux Saumons River (Anticosti Island)	Light-to-moderate damage to 5% - 10% of the young trees over 20-km distance.
	Black spruce	La Verendrye Reserve, along Highway 117	Moderate defoliation.
		South of Montbeillard, along Highway 101 (Témiscamingue)	Moderate defoliation.

Western and Northern Region

Insects, Disease, or Damage	Host	Location	Remarks
Abiotic damage			
Chemical injury Herbicides, road salts, soil sterilants	Several species	Alberta Saskatchewan	Several inquiries and diagnoses made; most are road salt injury to conifers and soil sterilant injury to various species.
Frost injury	Many species	Prairie Provinces Northwest Territories	Various degrees of injury reported region-wide on many species.
Animal damage			
Porcupine	Apple Lodgepole pine Scots pine	British Columbia Alberta Northwest Territories	Top kill resulting from girdling common at several locations in Banff, Jasper, Lootenay and Yoho National parks. Damage to Scots pine in Edmonton. Several patches of damaged trees in the Kotaneelee and South Nahanni river valleys.
Snowshoe hare	Lodgepole pine	Northwest Territories	Scattered patches of tree girdling in Yellowknife Forest District.
Squirrel	Jack pine Lodgepole pine	Alberta Manitoba Northwest Territories	Tip and branch mortality common in Jasper, Banff, Kootenay and Waterton Lakes National Parks. Light damage near Janpeg, Manitoba and near Ft. Smith and Trout River, Northwest Territories.
Aphids, open-feeding, several species	Conifer and deciduous hosts	Prairie Provinces	Populations were prominent and common on forest regeneration, plantations, and urban trees and shrubs.
Aspen blotchminer *Lithocolletis tremuloidiella* Braun	Aspen	Prairie Provinces	Common occurrence in many areas.
Aspen/poplar leaf and twig blight *Venturia macularis* (Fx.) E. Müller *Venturia populina* (Vuill.) Fabric.	Aspen Poplar	Prairie Provinces	Common on regeneration in the two provinces and along the Nyarling River, Northwest Territories.
Atropellis canker *Atropellis piniphila* (Weir) Lohman and Cash	Lodgepole pine	Alberta Saskatchewan	Infections noted in Kananaskis Country, Waterton Lakes National Park, between Nordegg and Red Deer River and in Cypress Hills.
Birch leaf miners *Fenusa pusilla* (Lepeletier) *Profenusa thomsoni* (Konow)	Birch species	Prairie Provinces	Moderate to severe infestations in many urban areas; high infestations noted in many native stands, likely due mostly to *P. thomsoni*.
Black-knot of cherry *Apiosporina morbosa* (Schw.) Arx.	Chokecherry Mayday	Alberta Saskatchewan	Common in many areas.
Black-stain root disease *Verticicladiella wageneri*	Alpine fir Englemann spruce Lodgepole pine	Alberta	Infections found in association with tree mortality in Rocky Mountain National Parks.
Boxelder twig borer *Proteoteras willingana* (Kft.)	Manitoba maple	Alberta Saskatchewan	Commonly observed in many areas.

Western and Northern Region, cont.

Insects, Disease, or Damage	Host	Location	Remarks
Bronze birch borer *Agrilus anxius* Gory	Birch species	Prairie Provinces	Associated with birch dieback, mostly in urban areas. Specific reports form Devon, Lethbridge, and Regina.
Bruce spanworm *Operophtera bruceata* (Hulst)	Aspen	Alberta Saskatchewan	Low populations observed in Cypress Hills, between Calgary and Turner Valley and west of Stettler.
Clearwing moth *Synanthedon* sp.	Pine Spruce	British Columbia Alberta Saskatchewan	Girdling injury and resinosis common on many urban plantings. Branca and stem girdling observed in Redstreak Campground, Kootenay National Park and at several locations in Banff National Park.
Cytospora canker *Cytospora chrysosperma* (Pers.) Fr.	Mountain ash Poplar	Prairie Provinces	Some increased incidence noted, probably resulting from late-spring frost injuries in late-May.
Douglas-fir beetle *Dendroctonus pseudotsugae* Hopk.	Douglas-fir	British Columbia Alberta	Low populations near Annette and Patricia lakes, Jasper National Park and in Redstreak Campground, Kootenay National Park.
Early aspen leafcurler *Pseudexentera oregonana* Wlshm.	Aspen	Prairie Provinces	Light and moderate leaf injury reported in many areas: Pine Falls, Gypsomville, Lake Francis and Spruce Woods Prov. Forest, Manitoba. Also south of Calgary, near Valleyview, Alberta and near Prince Albert and Yorkton, Saskatchewan.
Eastern black-headed budworm *Acleris variana* (Fernald)	Spruce	Prairie Provinces	Light-to-moderate defoliation reported at several locations.
Fall cankerworm *Alsophila pometaria* (Harris)	Elm Green ash Manitoba maple	Prairie Provinces	Caused light-to-severe defoliation at several locations in Saskatchewan and Manitoba; light defoliation in southern Alberta.
Fireblight *Erwinia amylovora* (Burrill) Winslow et al.	Apple Cotoneaster Mountain ash Plum	Alberta Saskatchewan	Fewer incidences of infection were reported compared to previous years.
Gray willow leaf beetle *Pyrrhalta decora decora* (Say)	Willow species	Alberta Saskatchewan	Patches of moderate-to-severe skeletization injury in Kootenay, Banff, Jasper, and Prince Albert national parks; also near Athabasca, Rochester, Sylvan Lake and Eckville, Alberta.
Green-headed spruce sawfly *Pikonema dimmokii* (Ajzenberg)	Spruce	Alberta Manitoba	Low populations observed near Powerview and Moose Lake.
Honeysuckle aphid *Hyadaphis tataricae* (Ajzenberg)		Prairie Provinces	Common on urban and rural plantings, causing rosetting and brooming of terminal shoots.
Hypoxylon canker *Hypoxylon mammatum* (Wahlenburg) J.H. Miller	Aspen	Prairie Provinces	Infection incidence is common especially across central part of region.
Jack pine sawfly *Neodiprion virginianus* Complex.	Jack pine	Alberta Saskatchewan	Colonies of larvae observed inplantations near Chip Lake, Alberta and near Macdowall, Saskatchewan.

Western and Northern Region, cont.

Insects, Disease, or Damage	Host	Location	Remarks
Leaf beetles *Chrysomela* spp.	Aspen Poplar	Alberta Saskatchewan	Skeletonizing and defoliation injury noted in Banff, Kootenay, Jasper, Waterton Lakes and Prince Albert national parks.
Leaf miner *Lyonetia* sp.	Willow	Alberta Saskatchewan Northwest Territories	Mostly light mining injury at several locations in central Saskatchewan including Prince Albert National Park, northern Alberta, and southern Northwest Territories.
Leaf rust *Melampsora medusae* Theum.	Aspen Poplar	Alberta	Infections were common in Rocky Mountain National parks, less common along the Alberta foothills.
Lodgepole needleminer *Coleotechnites starki* (Free.)	Lodgepole pine	Alberta	Moderate-to-severe mining between Saskatchewan Crossing and Weeping Wall, B.N.P., covering 52 km^2. Light injury on Mt. Norquay near Banff.
Lodgepole pine beetle *Dendroctonus murrayanae* Hopk.	Jack pine Lodgepole pine	Alberta	Observed at several locations in Jasper and Banff National parks, often associated with fire-killed or dying pine.
Lodgepole terminal weevil *Pissodes terminalis* Hopping	Jack pine Lodgepole pine	Prairie Provinces	Incidence common in young stands including nurseries and plantations. Light incidence near Saskatchewan Crossing, B.N.P.
Nelson's juniper rust *Gymnosporangium nelsonii* Arth.	Juniper Saskatoon	British Columbia	Infections common in Restreak Campground, Kootenay National Park and near Field, Yoho National Park.
Northern pitch twig moth *Petrova albicapitana* (Busck)	Jack pine Lodgepole pine	Prairie Provinces Northwest Territories	common in naturally and artificially regenerated areas.
Pine needle casts *Davisomycella ampla* (Davis) Darker *Elytroderma deformans* (Weir) Darker *Lophodermella concolor* (Dearn.) Darker	Jack pine Lodgepole pine	Alberta Manitoba	Low incidence of infection of *E. deformans* and *L. concolor* along the Alberta foothills and in Rocky Mountain National Parks. *D. ampla* caused light damage in plantation near Marchand, Manitoba.
Pine needle scale *Phenacaspis pinifoliae* (Fitch)	Pine White spruce	Prairie Provinces	Infestations common in many regeneration sites, including some plantations near Mortlach and Border, Saskatchewan.
Poplar blackmine beetle *Zeugophora scutellaris* Suff.	Poplar	Alberta Saskatchewan	Light-to-moderate injury observed at several locations in southern Alberta, at Big River and Prince Albert nurseries, and in Saskatoon., Sask.
Poplar borer *Saperda calcarata* Say.	Aspen Poplar	Alberta Manitoba Northwest Territories	Common in many mature and semi-mature aspen stands in central and southern parts of the provicnes. Common incidence in poplar stands growing along some river drainages in Northwest Territories.
Poplar serpentine miner *Phylocnistis populiella* Chambers	Aspen	Prairie Provinces Northwest Territories	Low incidence reported in many areas of the region.

Western and Northern Region, cont.

Insects, Disease, or Damage	Host	Location	Remarks
Prairie tent caterpillar *Malacosoma californicum lutescans* (N.&D.)	Chokecherry Poplar	Alberta Manitoba	Moderate and severe defolaition noted at several locations in Alberta; moderate injury on chokecherry n Spruce Woods Provincial Forest, Manitoba.
Red belt	Lodgepole pine	Alberta	Light to severe injury in the foothills area south of Grande Prairie.
Septoria canker *Mycoshaerella populicola* G.E. Thompson *Septoria caraganae* Karst.	Caragana Poplar	Alberta Saskatchewan	Infection and "shot holes" common, especially in urban plantings. Higher incidence of infection on hybrid poplar in central Alberta; low incidence in Prince Albert Prov. Nursery. *S. cariganae* caused light to moderate injury to a caragana shelterbelt near Prince Albert.
Shot-hole of cherry *Coccomyces heimalis* Higgins	Chokecherry	Alberta Saskatchewan	Infection and "shot-holes" common, especially in urban plantings.
Silver leaf *Chondrostereum purpureum* (Pers. Fr.) Pouzar (=Stereum purpureum)	Apple Cotoneaster Mountain ash Plum	Alberta	Common infections on mature trees in several urban areas.
Spittlebug *Aphrophora* sp.	Jack pine	Manitoba	Low to high populations in young stands in southeastern Manitoba.
Spruce bud midge *Rhabdophaga swainei*	White spruce	Alberta Saskatchewan Northwest Territories	Common in forested areas of the provinces and near Chan Lake and Edzo, Northwest Territories.
Spruce gall aphids *Adelges* spp. *Pinius* spp.	Douglas-fir Pine Spruce	British Columbia Alberta Saskatchewan	Common where host trees occur.
Spruce needle cast *Lirula macrospora* (Hartig) Darker	White spruce	Alberta	Several infections reported from Alberta foothills.
Spruce needle rust *Chroysomyza ledicola* Lagh.	White spruce	British Columbia Alberta Saskatchewan	Light and moderate infection incidence in Rocky Mountain National Parks. Low infection in central Saskatchewan.
Spruce spider mite *Oligonychus ununguis* (Jacobi)	Cedar Juniper Spruce	Region-wide	Common pest of planted trees in urban areas and farm shelterbelts, especially in mature trees.
Stalactiform blister rust *Cronartium coleosporioides* Arth.	Lodgepole pine	Alberta	Infections and injury common at Saskatchewan Crossing, Banff National Park and near Athabasca Falls, Jasper National Park.
Two-year-cycle spruce budworm *Choristoneura biennis* Free.	Alpine fir Engelmann spruce	British Columbia Alberta	Low and moderate populations at Numa Creek, Kootenay National Park, near Emerald Lake in Yoho National Park, and at Saskatchewan Crossing, Banff National Park.
Uglynest caterpillar *Archips californicus* (Fitch)	Chokecherry	Alberta Saskatchewan	Common in central and southern Alberta, and near Macdowall, Saskatchewan.

Western and Northern Region, cont.

Insects, Disease, or Damage	Host	Location	Remarks
Western ash bark beetle *Leperisinus californicus* Swaine	Green ash	Alberta Saskatchewan	Commonly reported causing tree injury in Medicine Hat, Lethbridge, Strathmore, and Calgary areas in Alberta and in Saskatoon, Swift Current, and Regina areas in Saskatchewan.
Western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka	Jack pine Lodgepole pine Scots pine	Alberta Saskatchewan Manitoba Northwest Territories	Branch and stem infections common in many young stands region-wide. Infections noted on Scots pine near Rockglen, south of Regina.
White pine weevil *Pissodes strobi* (Peck)	Colorado spruce White spruce Jack pine	Prairie Provinces	Important pest species causing two or more years of top kill in plantations and other high-value stands. Common in Rocky Mt. national parks.
Yellow-headed spruce sawfly *Pilonema alaskensis* (Rohwer)	Colorado spruce White spruce	Region-wide	Common defoliator pest of young planted spruce in urban areas, plantations, shelterbelts and nurseries. Chronic infestations in some areas.
Yellow witch's broom *Chrysomyza arctostaphyli* Diet.	Spruce	Region-wide	Common disease in many semi-mature and mature stands.

Pacific and Yukon Region

Insect, Disease, or Damage	Host(s)	Location	Remarks
Abiotic damage Sunscald	Douglas-fir	Vancouver region	Stem and branch damage to young stands and seed orchards.
Animal damage (voles, squirrels, porcupines)	Lodgepole pine Western hemlock White spruce	Prince Rupert region	Extensive young seedling mortality, up to 20% of trees in young plantations girdled.
		Prince George region	Girdling damage increased.
Ambermarked birch leafminer *Profenusa thomsoni* (Konow)	White birch Trembling aspen	Prince George region	Increased intensity, up to 80% leaves infested on trees within city limits.
		Nelson and Kamloops regions	Range extension to the southeast.
Anthracnose *Gloeosporium* sp.	Dogwood	Vancouver region	Light mortality continued on Lower Mainland and eastern Vancouver Island.
Aspen skeletonizer *Phratora purpurea purpurea* Brown	Trembling aspen	Prince George region	Populations collapsed.
Atropellis canker *Atropellis piniphila* (Weir) Lohman & Cash	Lodgepole pine	All regions	Severe in dense growing lodgepole pine averaging 57% trees infected in several locations in Cariboo region. Endemic levels were observed elsewhere.
Balsam woolly adelgid *Adelges piceae* (Ratzeburg)	Amabilis fir	Vancouver region	Discovered at West Thurlow Island beyond the quarantine zone.
Birch leaf skeletonizer *Lyonetia saliciella* Bsk.	White birch	Nelson region	Up to 70% foliage discolouration for 13th consecutive year in northern portion of region.
Black stain root disease *Ceratocystis wageneri* Goheen & Cobb	Douglas-fir	Nelson region	Common in *Armillaria*-infected stands along Kinbasket Lake.
Blight on seedlings *Rosellinia minor* (Hoehn.) S. Francis	Engelmann spruce	Vancouver region	First record in British Columbia on seedlings at Maple Ridge.
Blight on shoots *Sirococcus strobilinus* Preuss	Mountain hemlock	Prince Rupert region	New host record caused foliage dieback on regeneration near Port Clements.
Blight on shoots *Sydowia polyspora* (Bref. & Tav.) E. Muell.	Balsam fir	Takhini Forest Reserve, Yukon	New host record, killing frost damaged terminals.
Canker *Nectria cinnabarina* (Tode ex Fr.) Fr.	Siberian elm	Merritt	New host record.
Canker *Nitschkia molna* ? Funk	Whitebark pine	Smithers	New host record.
	Douglas-fir	Campbell River	Conspicuous cankering on 15% of young planted trees.
Conifer-aspen/cottonwood rust *Melampsora medusae* Thuem. *Melampsora occidentalis* Jacks.	Douglas-fir	Nelson	Common in wet belt zone causing 60-100% infection of new growth.
Conifer weevil *Magdalis gentilis* LeConte	Lodgepole pine	Cariboo region	Increased populations severely defoliated the current year's growth of young trees in three areas. This is the first record of significant defoliation caused by adult feeding.

Pacific and Yukon Region, cont.

Insect, Disease, or Damage	Host(s)	Location	Remarks
Cooley spruce gall adelgid *Adelges cooleyi* (Gill.)	Engelmann, Sitka, white spruce Douglas-fir	Nelson, Kamloops, Vancouver regions	Widespread needle discolouration common in young Douglas-fir stands.
Cypress bark moth *Cydia cupressana* (Kearfoot)	Eastern white cedar	Kelowna, Victoria	First record in British Columbia.
Cypress tip moth *Argyresthia* sp.	Ornamental cypress	Victoria	Again common, causing severe tip dieback.
Dieback (branch) *Tympanis* sp.	Trembling aspen	Teslin	New host record for the Yukon.
Dieback (twig) *Godronia multispora* Groves	White birch	Revelstoke	First record in British Columbia.
Dieback fungi			
Ascocalyx sp.	Douglas-fir Western larch Engelmann spruce	McLeod Lake Houston Horsefly	New host record. ▪ ▪ ▪ ▪ ▪ ▪
Cladosporium sp.	Siberian larch	Fort Nelson	New host record.
Kabatina juniperi Schneider & Arx	Rocky Mountain Juniper	Savona	New host record.
Phacidium gaeumannii (Muller) Di Cosmo, Nag Raj & Kendrick	Norway spruce Douglas-fir Western larch Western hemlock Engelmann spruce	Fort Nelson Hope, Vavenby Grand Forks Nakusp Horsefly	New host record. ▪ ▪ ▪ ▪ ▪ ▪ ▪ ▪ ▪ ▪ ▪ ▪
Phoma sp.	Siberian larch	Fort St. James	New host record.
Sclerophoma semenospora Funk	Ponderosa pine	Rock Creek	New host record.
Sclerophoma sp.	Siberian larch	Fort St. James	New host record.
Tympanis laricina (Fckl.) Sacc.	Western white pine	Nanaimo	New host record.
Dime canker *Durandiella pseudotsugae* Funk	Douglas-fir	Nelson region	Cankers on 48% of immature trees over 40 ha at Wilson Lake.
Douglas-fir coneworm *Dioryctria pseudotsugella* Munroe	Douglas-fir	Cariboo region Kamloops region	Current year's growth moderately to severely defoliated over 430 ha along Williams Lake and 190 ha on Sheep Creek Hill. Associated with western spruce budworm defoliation in Thompson River drainage and Okanagan Valley.
Douglas-fir beetle *Dendroctonus pseudotsugae* Hopk.	Douglas-fir	All regions	Populations remain scattered and at low levels.
Douglas-fir tussock moth *Orgyia pseudotsugata* (McD.)	Douglas-fir	Kamloops and Nelson regions	Increased number of adults in pheromone traps for the second consecutive year. Defoliation is expected in 1988-89.

Pacific and Yukon Region, cont.

Insect, Disease, or Damage	Host(s)	Location	Remarks
Dwarf mistletoe *Arceuthobium tsugense* (Rosendahl) G.N. Jones	Western hemlock	Prince Rupert and Vancouver regions	Scattered throughout the coastal host range causing increment reduction.
Eastern spruce gall adelgid *Adelges abietis* (L.)	Sitka spruce	Victoria	First record of European species in British Columbia.
Elm leafminer *Agromyza aristata* Malloch	Elm	Prince George region	Populations increased, 80% of leaves infested on ornamental elms.
Elytroderma needle disease *Elytroderma deformans* (Weir) Darker	Ponderosa pine Lodgepole pine	Kamloops region Nelson region Prince Rupert region	Common and widespread with up to half the older needles infected on some trees. Moderate infections in regeneration in northern portion of region.
Engraver beetle *Ips tridens* (Mannerheim)	White spruce	Prince George region	Continued infestation of windthrown trees throughout the Bowron River drainage.
European pine shoot moth *Rhyacionia buoliana* (D.&S.)	Ornamental pines	Kamloops region Victoria	Light infestation of branch tips on 90% of trees at Penticton. Light bud mining.
Fletcher scale *Parthenolecanium fletcheri* Cockerell	Eastern white pine	Penticton Kelowna	First record in British Columbia.
Fly speck fungus *Leptopeltis* sp.	Yellow cedar	Sooke Slocan Park	First record in British Columbia.
Green velvet looper *Epirrita* sp.	Alpine fir	Smithers	80% defoliation of new foliage over 150 ha.
Hemlock-willow foliar rust *Melampsora epitea* Thuem.	Willow	Prince Rupert	Early yellowing and leaf drop common in Skeena, Kalum, and Kitimat valleys.
Honey locust podgall midge *Dasineura gleditchiae* (O.S.)	Honey locust	Victoria, Kelowna, Nelson	First record in British Columbia.
Hyperparasitic fungus *Aegerita fungicola* (Zeller) Hennebert	Pyrenomycete on western hemlock	Parksville	New host record.
Mistletoe hyperparasites			
Cladosporium sp.	Lodgepole pine dwarf mistletoe	Parson	New host record on dwarf mistletoe seeds.
Glomerella cingulata (Stonem.) Spauld. & Schrenk	Western larch dwarf mistletoe	Grand Forks	New host record, at Christina Lake.
Wallrothiella arceuthobii (Pk.) Sacc.	Lodgepole pine dwarf mistletoe	Burns Lake	70% of mistletoe seeds destroyed.
Larch casebearer *Coleophora laricella* (Hbn.)	Western larch	Nelson region Kamloops region	Pockets of light to severe defoliation continue. About 330 parasites released, bringing to more than 15 000 the number of introduced parasites released by FIDS since 1966. Larval populations increased at Vernon, but no damage evident.
Larch sawfly *Pristophora erichsonii* (Htg.)	Larch Tamarack	Terrace Prince Rupert region	New distribution record on exotic larch. Moderate defoliation near Yukon border.

Pacific and Yukon Region, cont.

Insect, Disease, or Damage	Host(s)	Location	Remarks
	Western larch	Nelson region	Light to moderate defoliation on 700 ha near Fernie and Dutch Creek.
Large aspen tortrix *Choristoneura conflictana* (Wlk.)	Trembling aspen	Yukon Territory Prince Rupert	Light defoliation for 10 km between Faro and Ross River. Moderate defoliation over 150 ha at Trout Creek.
Leaf Blights			
Phyllosticta sp.	Horse chestnut	Harrison Lake	New host record.
Microstroma juglandis (Bereng.) Sacc.	Walnut	North Pender Island	New host record.
Taphrina sp.	Plum	Saanichton, near Victoria	New host record.
Leaf miner *Leucoptera laburnella* Stainton	Laburnum	Campbell River	New distribution record.
Leaf Spots			
Pollaccia sp.	Trembling aspen	Cassiar, Dawson City	New disease record for British Columbia and the Yukon.
Septoria aceris (Lib.) Berk. & Br.	Vine maple	North Vancouver	New host record.
Septoria alnifolia Ell. & Ev.	Sitka alder	Slocan Valley and along Highway 23 to Revelstoke.	First record in British Columbia.
Mycosphaerella sp.	European mountain ash	Takhini Forest Reserve near Whitehorse	New host record for the Yukon.
Lodgepole pine beetle *Dendroctonus murrayanae* Hopk.	Lodgepole pine	Prince George and Prince Rupert regions	Scattered attack causing light mortality.
Lodgepole terminal weevil *Pissodes terminalis* Hopping	Lodgepole pine	Cariboo region Prince Rupert region	Leader mortality at four study sites declined to an average of 6%. Average 20% leader mortality at seven sites in interior of the region.
Maple leaf scorch (unknown cause, possibly bacteria)	Broadleaf maple	Vancouver region	Severe foliar browning throughout host range causing branch dieback.
Needle Blights			
Didymascella thujina (Durand) Maire	Western red cedar	Hazelton	Affected 15% of foliage on 20% of trees and up to 80% defoliation of the understorey.
Meria laricis Vuill.	Western larch	Nelson and Kamloops regions	Infections generally increased in conjunction with *Hypodermella laricis*.
Hypodermella laricis Tub.	Western larch	Kamloops region	30-100% discolouration patchy from Kelowna to Falkland.
Isthmiella abietis (Desm.) Darker	Alpine fir	Nelson region	80% of foliage infected at Blazed Creek.

Pacific and Yukon Region, cont.

Insect, Disease, or Damage	Host(s)	Location	Remarks
Lophodermella concolor (Dearn.) Darker	Lodgepole pine	Nelson region	Common in Cranbrook, occasionally severe and more widespread than 1986.
Phaeocryptopus gaeumannii (Rohde) Petr.	Douglas-fir	Vancouver Island	80% of trees lightly infected in one plantation at Wilson Lake.
Rhabdocline spp.	Douglas-fir	Vancouver region	Severe defoliation at Chipmunk Creek, 82% of 12-year-old trees affected
Needle rust *Pucciniastrum epilobii* Otth	Amabilis fir	Nelson and Prince Rupert regions	Common in many pockets, often affecting most of the current year's growth.
Pacific willow leaf beetle *Pyrrhalta decora* carbo (LeC.)	Willow	Nelson region	Populations expanded south and east of Revelstoke.
Pale spruce gall adelgid *Adelges strobilobius* (Kaltenbach)	Black spruce	Fort St. John	First record in British Columbia.
Pine butterfly *Neophasia menapia* (C. & R. Felder)	Douglas-fir	Vancouver Island	Adults again common but no defoliation.
Pine engraver *Ips pini* (Say)	Lodgepole pine	Nelson region	Common in Boundary District in conjunction with mountain pine beetle occasionally causing mortality.
		Cariboo region	Populations increased significantly, 7250 pockets of mortality over 3400 ha.
Pine leaf adelgid *Pineus pinifoliae* (Fitch)	Grand fir	Prince Rupert region	Common but light in pockets in southern portion of the region.
Pine needle scale *Chionaspis pinifoliae* (Fitch)	Grand fir	Sidney	New host record in British Columbia.
Pine needle sheathminer *Zelleria haimbachi* Bsk.	Lodgepole pine	Kamloops region	Continued high populations from Adam Lake to Salmon Arm.
		Vancouver and Prince Rupert regions	Populations increased with scattered severe feeding on new shoots of young trees.
		Nelson region	Light to severe discolouration of current needles in four infestations totalling 200 ha.
Poplar borer *Saperda calcarata* Say	Trembling aspen	Yukon Territory	Common, scattered.
Poplar shoot blight *Venturia macularis* (Fr.) Mull. & Arx and *Venturia populina* (Vuill.) Fabric.	Trembling aspen Black cottonwood	All regions	Infections decreased from previously high levels.
Poplar-and-willow borer *Cryptorhynchus lapathi* (L.)	Willow	Cariboo region Prince George region	More common and widespread. Recovery from Prince George and McBride represent significant expansion of its known range.
		Prince Rupert region	Increased populations killed numerous shoots and stems.
Red band disease *Scirrhia pini* Funk & Parker	Western white pine Lodgepole pine	Nelson region	Scattered light to moderate needle discolouration between New Denver and Nakusp.

Pacific and Yukon Region, cont.

Insect, Disease, or Damage	Host(s)	Location	Remarks
Resin fungus *Claussenomyces olivaceous* (Fckl.) Sherw.	Grand fir	Vancouver region	New host record at Sechelt.
Root rot *Phytophthora cactorum* (Leb. & Cohn) Shroet.	Arbutus	Victoria	New host record.
Rust *Gymnosporangium nidus-avis* Thaxt.	Sitka mountain ash	Prince George region	New host record, near Bear Lake.
Satin moth *Leucoma salicis* (L.)	Trembling aspen Black cottonwood Poplar	Nelson region Victoria	Populations decreased since 1986, no defoliation noted. Continuing population causing light defoliation of poplar.
Saprophyte on bark *Stemphylium* sp.	Willow	Grand Forks	New host record.
Saprophytic fungus *Pithya vulgaris* Fckl.	Atlas cedar	North Vancouver	New host record. Associated with *Sirococcus strobilinus* on stressed trees at one location.
Seedling weevil *Steremnius carinatus* (Boh.)	Western hemlock	Vancouver Island	Low levels of mortality on north end of Island.
Sequoia pitch moth *Synanthedon sequoiae* (Hy. Edwards)	Lodgepole pine	Wasa	50% of trees affected over 2 ha.
Silverspotted tiger moth *Lophocampa argentata* (Pack)	Douglas-fir	Vancouver Island	Occasional scattered colonies causing trace defoliation.
Spruce aphid *Elatobium abietinum* (Wlk.)	Ornamental spruce Sitka spruce	Vancouver region, Queen Charlotte Islands	Increased populations causing branch mortality and severe defoliation.
Spruce broom rust *Chrysomyxa arctostaphyli* Diet.	White spruce	Prince Rupert and Prince George regions, Yukon Territory	One to several perennial brooms common per tree causing mortality or top-kill and growth losses.
Spruce bud moth *Zeiraphera* sp.	Sitka spruce White spruce	Nelson, Vancouver, Prince George, Prince Rupert regions	Infested 1-5% of buds on 10-70% of trees in 4 stands. Infested 3% of buds on 40% of trees in four stands.
Spruce bud scale *Physokermes piceae* (Schrank)	Grand fir	Sidney	New host record.
Spruce gall adelgid *Adelges lariciatus* (Patch)	Black spruce	Fort Nelson	First record in British Columbia.
Striped alder sawfly *Hemichroa crocea* Geoff.	Red alder	Prince Rupert	Generally light defoliation.
Sydowia tip dieback *Sclerophoma pithyophila* (corda) Hoehn.	Lodgepole pine Douglas-fir	Prince George region Yukon Territory	Scattered top dieback in young pine in Takhini Forest Reserve and on Douglas-fir planted west of Canol Lake.
Tip blight *Delphinella* spp.	Alpine fir	Prince Rupert and Prince George regions	Moderate to severe infection of current growth in central Prince Rupert region. Declined in Prince George with localized infections around Bear Lake.

Pacific and Yukon Region, cont.

Insect, Disease, or Damage	Host(s)	Location	Remarks
Variegated cutworm *Peridroma saucia* (Hubner)	Lodgepole pine White spruce	Cariboo region	Infestation collapsed, very low numbers caught in pheromone traps.
Warren's root collar weevil *Hylobius warreni* Wood	Lodgepole pine	All regions	Common in young plantations, causing less than 1% mortality.
Western balsam bark beetle, *Dryocoetes confusus* Swaine	Alpine fir	All regions	Mortality continues in chronically infested stands over 117 000 ha throughout British Columbia.
Western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka	Jeffrey pine Lodgepole pine	Victoria All regions	New host record. Branch and stem galls common throughout host range.
Western hemlock looper *Lambdina fiscellaria lugubrosa* (Hulst)	Western hemlock Western red cedar Broadleaf maple	Vancouver region	A new infestation causing severe defoliation over 90 ha on west side of Jervis Inlet.
Western pine beetle *Dendroctonus brevicomis* LeConte	Ponderosa pine	Nelson region	Scattered mortality continues in Boundary and Arrow Districts.
Western pine shoot borer *Eucosma sonomana* Kft.	Ponderosa pine	Nelson region	Causing minor twig dieback between Christina Lake and Grand Forks.
Western winter moth *Erannis tiliaria vancouverensis* (Hulst)	Birch Maple Poplar, willow	Kamloops, Cariboo and Vancouver regions	Widespread in mixed deciduous stands causing up to 75% defoliation.
Western tent caterpillar *Malacosoma californicum pluviale* (Pack.)	Deciduous species	Vancouver region	Populations declined in southwestern British Columbia due to increased virus infections.
White pine weevil *Pissodes strobi* (Peck)	Sitka, White, Engelmann spruce	Prince Rupert region Prince George and Nelson regions	From 2-58% of the current leaders attacked in stands near Kitimat. Widespread scattered attack. Occasionally on roadside spruce and 3% of current leaders attacked over 3 ha at Rock Cr.
Winter moth *Operophtera brumata* (L.)	Garry oak Maples Fruit trees	Southeastern Vancouver Island	Trace-to-light defoliation continued in scattered patches.
Yellow cypress rust *Gymnosporangium nootkatense* Arth.	Yellow cedar	Queen Charlotte Islands	First collection from yellow cedar on the QCI, but only at trace level near Rennell Sound.

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Forestry Canada Forêts Canada

Supplement to

Forest Insect and Disease Conditions in Canada 1987

Forestry Canada was formerly known as the Canadian Forestry Service

Special Surveys

Pinewood nematode

Bursaphelenchus xylophilus (Steiner and Buhrer) Nickle
Reported as *B. lignicolus* in 1985 FIDS report

British Columbia

This species was found at only four locations in 1987. It occurred in small numbers in two species of previously damaged or predisposed conifers and within one adult woodborer. The nematode is not conspicuous or damaging within the forests of British Columbia and the Yukon, based on a sampling of about 500 declining trees and 500 potential vectors since 1983.

The Biosystematic Research Centre confirmed identification of *Bursaphelenchus xylophilus* isolated from an adult woodborer *Monchamus maculosus* Hald. captured near Wasa Lake in the Nelson Region. *Bursaphelenchus* ("m" form) were also identified from a fire-killed, standing Douglas-fir near Skookumchuck, not far from where a ponderosa pine was found infected in 1986. A recent mountain pine beetle-killed lodgepole pine along the Tranquille River near Kamloops also contained *Bursaphelenchus* ("m" form). Near Lower Post along the British Columbia-Yukon border, *B. xylophilus* was extracted from lodgepole pine in a 3-year-old log deck. Other species of *Bursaphelenchus* (not *xylophilus*) were collected from individual, recently killed lodgepole pine near Smithers, Prince George, Creston, and Brisco. Of the 158 trees sampled in 1987, 61 had nematodes but only seven contained *Bursaphelenchus*. Most commonly the nematodes extracted were insect associates or bacterial feeders along with a few *Aphelenchoides*, *Ditylenchus*, *Cryptaphelenchus*, or *Ektaphelenchus*.

A collection of 439 adult woodborers, mostly from log decks, were extracted for nematodes. This collection included 17 species of cerambycids, eight species of buprestids, and five species of siricids. The most common woodborer examined (246) was *Monochamus scutellatus* (Say); 12% contained various nematodes. Other woodborers with nematodes included *M. maculosus* (18%), *Buprestis rusticorum* Kirby (16%), and *B. nuttallii* Kirby (23%). Less frequently collected were *M. notatus* (Drury), *Xylotrechus undulatus* (Say), and *Dicera tenebrosa*, Kirby. In most cases the nematodes extracted from adult woodborers were free-living bacterial feeders in the Tylenchidae or Rhabdidae and occasionally Aphelenchidae. Only the one *M. maculosus* from near Wasa Lake in the Nelson Region contained *B. xylophilus*.

Baited barrier traps and sticky traps placed adjacent to wood chip piles at pulp mills in Crofton and Prince George and near sawmills at Williams Lake and the Upper Fraser Valley attracted mainly leaf beetles *Altica tombacina* Mannerheim and weevils of herbaceous vegetation, plus only one woodborer. Lindgren traps at sawmills near Smithers attracted small numbers of adult buprestid woodborers.

Other Insects, Disease, and Damage

Ontario

Insects, Disease, or Damage	Host(s)	Location	Remarks
A beech leafminer *Phyllonorycter* possibly *restrictella* Braun.	Beech	Brockville District	Noticeable browning on 20% of roadside regeneration in Front of Escott Township
A mite *Eriophyes* sp.	Trembling aspen	Wawa District	Heavy infestation caused 50-75% defoliation of 50 ha of immature trees in Huotari Township.
Abiotic damage			
Blowdown	Coniferous Deciduous	Nipigon District	A total of 1750 ha of blowdown was reported.
		Algonquin Region	Single trees or small pockets of blowdown were observed in parts of the Bracebridge and Minden districts.
	Jack pine Trembling aspen	Fort Frances District	Surveys revealed a 53 ha area of damage.
Drought	Hardwoods	Algonquin, Central, Eastern, and Northwestern regions	Foliar discoloration and premature defoliation of trees growing on shallow sites was recorded in several areas.
Frost	White spruce Balsam fir	North Central, Northern, and Northwestern regions	Widespread moderate-to-severe foliar damage in parts of three regions, with shoot mortality of 100% recorded in some areas.
	Trembling aspen	North Central, Northeastern, and Northwestern regions	Widespread but sporadic pockets of semi-mature and mature trees experiencing 30-100% foliar damage were observed.
	White spruce deciduous trees	Algonquin Region	Widespread damage caused 90-100% shoot loss at numerous locations.
	White spruce Balsam fir	Eastern and Southwestern regions	Damage not widespread and, except for a couple of localized areas, associated foliar damage was less than 10%.
Hail	Deciduous	Algonquin Park and Pembroke districts	An early summer storm resulted in foliar damage as high as 95% across a 3440 ha area.
Leaf scorch	Sugar maple Norway maple	Southwestern Region	Symptomatic damage was widespread, with an average of 10% foliar damage.
Salt damage	Conifers	Bracebridge, Minden, Maple, Huronia, Parry Sound, Sudbury, and North Bay districts	Heavy damage to roadside trees and plantations.
		Lindsay District	Moderate mortality of conifers reported along Highway 115 east of Highway 35.
Snow and ice damage	Hardwoods	Brockville and Cornwall districts	Two separate storms accounted for numerous pickets (0.5 ha on average) of severely damaged (>75%) crowns.
Sunscald	White pine	Algonquin Region	Individual trees or small groups of trees having up to 60% of the foliage affected in the Algonquin Park and Pembroke districts.

Ontario, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Winter drying	Eastern white cedar	Southwestern Region	The incidence of trees affected in windbreaks and windrows ranged from 20-60% and associated foliar damage was less than 10%.
	Eastern white cedar White spruce	Thunder Bay District	Damage to young windbreaks and transplant stock was observed in the Thunder Bay Forest Nursery.
	Red pine White pine	Algonquin Region	Up to 100% foliar damage to individuals or small pockets in the Bancroft and Pembroke districts.
American aspen beetle *Gonioctena americana* (Schaef.)	Trembling aspen	Northern Ontario	Defoliation generally less than 20%; occurred at several locations from Thunder Bay District east at Kirkland Lake District. Small localized areas of heavier damage (40-60%) in Panet and Chappise townships, Chapleau District.
	Balsam poplar Trembling aspen	Algonquin Region	Medium and heavy infestations with defoliation levels from 40-95%; common in Pembroke and Bancroft districts.
An elm flea beetle *Altica* possibly *carinata* Germ.	White elm	Fort Frances District	Moderate numbers caused 70% foliar damage in McIrvine Township.
Anthracnose *Apiognomonia errabunda* (Roberge) Höhnel	Basswood Beech Maple Oak	Algonquin, Eastern and Northeastern regions	Moderate-to-severe foliar damage (25%) on roadside trees, with up to 50% of host trees being affected.
	White oak	Simcoe District	Assessment disclosed 15% branch mortality on one tree at a single location in Charlotteville Township.
Apiognomonia quercina (Kleb.) Höhnel	Red oak	Huronia District	Light foliar damage (<25%) was noted in the Wasaga Beach area.
Aureobasidium apocryptum (Ell. & Ev.) Hermanides-Nijhof	Sugar maple	Eastern Region	Roadside and fringe trees experienced up to 100% foliar damage at several locations in the Brockville, Carleton Place, Napanee, and Tweed districts.
	Red maple White birch	Fort Frances District	Small pockets of 100% incidence of attack; accompanying foliar infections of 90% in the Crowrock Inlet area.
Discula betulina (Westend.) v. Arx	White birch	Algonquin Region	Up to 90% foliar damage in some stands.
Discula campestris (Pass.) v. Arx	Sugar maple	Pembroke District	Up to 20% foliar infections on roadside trees in Horton Township.
Gnomonia caryae Wolf var. *caryae*	Hickories Walnuts	Eastern Region	Foliar damage ranging from 50-100% on occasional trees or small groups of trees in Brockville, Napanee, and Tweed districts.
Gnomomia leptostyla (Fr.) Ces. & de Not.	Butternut	Lindsay District	Surveys disclosed incidence was light, with accompanying foliar damage of 15% in Dummer Township.

Ontario, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Armillaria root rot *Armillaria mellea* (Vahl:Fr.) Kummer	Coniferous	Province-wide	Numerous regeneration assessments disclosed mortality commonly ranged from 1-3%.
	Black spruce	Northwestern Region	Mortality ranged from 1-10% in 11 black spruce seedling seed orchards evaluated.
Ash leaf spot *Mycosphaerella effigurata* (Schwein.) House	White ash	Napanee District	Complete foliar infection of scattered trees in Ferris Provincial Park.
Aspen leafblotch miner *Phyllonorycter ontario* (Free.)	Trembling aspen	Northern Ontario	Generally low and declining populations. Pockets of heavy damage persisted at some locations.
Aspen leafroller *Pseudexentera oregonana* Wilshm.	Aspen	Hearst District	Significant defoliation mapped across 9420 ha.
		Kenora, Terrace Bay, Nipigon, Geraldton, and Chapleau districts	Small populations at several locations.
Balsam fir sawfly *Neodiprion abietis* complex	Balsam fir	Northwestern Region	An area of 14 000 ha in the Bruce-Pakwash lakes area, Red Lake District averaged 10% defoliation. Light infestations also occurred in Kenora District where defoliation averaged 10-14%.
		Blind River and Sault Ste. Marie districts	Scattered stands suffered 25-50% foliar damage.
		Bancroft and Pembroke districts	Defoliation ranging from 20-30% at several locations.
		Tweed District	Two small areas of moderate-to-severe damage in Abinger Township.
Balsam poplar leaf diseases *Linospora tetraspora* G.E. Thompson *Mycosphaerella populicola* G.E. Thompson *Mycosphaerella populorum* G.E. Thompson	Balsam Poplar	Algonquin, Eastern, North Central, Northern, and Northwestern regions	Damage was widespread by one or more of these leaf disorders affecting entire stands and often causing 100% foliar damage.
		Central Region	Reduced infections were observed, with 30% foliar damage commonly recorded in Huronia District.
Beech scale *Cryptococcus fagisuga* Lindinger	Beech	Maple and Cambridge districts	Collected at six locations.
		Brockville District	Noted for the first time in Landsdowne Township.
Birch-aspen leafroller *Epinotia solandriana* Linn.	White birch Balsam poplar	Sudbury District	Defoliation over a 15 ha stand in Killarney Provincial Park, Sudbury District averaged 70%.
		Espanola District	Light defoliation at a number of scattered locations.

Ontario, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Birch leaf edgeminer *Scoleoneura betuleti* Klug.	White birch	Napanee District	Caused 75% foliar damage at Presqu'ile Provincial Park in Brighton Township; this represents a new distribution point.
Birch leafminer *Fenusa pusilla* (Lep.)	White birch	Province-wide	Scattered light damage in Northwestern Region. Elsewhere heavy damage common, primarily in urban areas and on open grown trees.
Birch sawfly *Arge pectoralis* (Leach)	White birch	Sudbury District	Heavy defoliation in McKim, Neelon, and Dryden townships.
		Eastern Region	Moderate-to-severe damage scattered throughout.
Birch tubemaker *Acrobasis betulella* Hlst.	White birch	Chapleau, Sudbury, and Espanola districts	Low-to-moderate defoliation periodically noted.
Black army cutworm *Actebia fennica* (Tausch)	Spruce	North Central Region	High populations caused light damage to seedlings of Thunder Bay Forest Tree Nursery.
Boxelder leafgall midge *Contarinia negundifolia* Felt	Manitoba maple	Cochrane and Chatham districts	Numerous infested ornamentals noted in a single location in both districts.
Cedar-apple rust *Gymnosporangium juniperi-virginianae* Schwein.	Red juniper	Brockville District	Surveys in several areas disclosed branch infections on up to 90% of the trees examined.
Cedar leafminers *Argyresthia thuiella* Pack., *A. aureoargentella* Brower, *A. canadensis* Free and *Coleotechnites thujaella* (Kft.)	Eastern white cedar	Espanola District	Defoliation ranged from 50-100% within an area of 10,000 ha along the southern shoreline of Manitoulin Island.
		Owen Sound District	Moderate-to-severe defoliation in Albemarle and Saugeen townships.
		Lindsay District	Increased populations caused 30-40% foliar damage at several locations.
Comandra blister rust *Cronartium comandrae* Peck	Jack pine	Northwestern Region	Trees affected averaged 1% or 2% at three locations and 10% at another in the southern part of the region.
Dutch elm disease *Ceratocystis ulmi* (Buism.) C. Moreau	White elm	Eastern Region	Affected trees ranged from 2-23%; recent mortality was less than 2%.
		Fort Frances District	Diseased trees averaged 51% and 19% in the respective urban centres of Rainy River and Fort Frances, with 19% and 11% recent mortality, respectively. A rural survey in McIrvine Township disclosed an incidence of 13%, with 4% mortality.
		Thunder Bay District	Examination revealed 9% of ornamentals diseased in the city of Thunder Bay.

Ontario, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
		Pembroke District	Roadside assessment disclosed 25% of trees diseased in Wilberforce Township.
Early birch leaf edgeminer *Messa nana* (Klug)	White birch	Northeastern and Algonquin regions	Extremely heavy population on open grown birch in McKim and Neelon townships, Sudbury District. New distribution range in area of the city of Sault Ste. Marie. Severe damage scattered through Cardiff Township, Bancroft District.
Eastern blackheaded budworm *Acleris variana* (Fern.)	White spruce	Red Lake District	Trace defoliation (<1%) on a few trees in a 3 ha plantation in Byshe Township.
Eastern gall rust *Cronartium quercum* (Berk.) Miyabe ex Shiraif. sp. *banksianae*	Red oak	Sault Ste. Marie District	Infections of medium intensity at one location in Tarentorus Township.
Eastern pine shoot borer *Eucosma gloriola* Heinr.	Jack pine White pine Red pine	Northwestern, Northern, Northeastern, and Algonquin regions	Routinely reported at low levels of damage (<5%).
Eastern tent caterpillar *Malacosoma americanum* F.	Deciduous species	Southern Ontario	Increased populations caused considerable damage to open-grown shrubbery and roadside trees.
European pine needle midge *Contarinia baeri* (Prell)	Red pine	Algonquin Region	Trace defoliation (1%) common through the work area. Low-to-moderate defoliation at two locations in Bancroft District.
European pine sawfly *Neodiprion sertifer* (Geoff.)	Jack pine Red pine Scots pine Mugho pine	Eastern Region	Moderate-to-severe defoliation in single red pine plantations in Hungerford Township, Tweed District.
		Northeastern Region	Moderate-to-severe damage to ornamentals in city of Sault Ste. Marie. Severe damage to open-grown Scots pine in Gordon Township, Espanola District.
		Algonquin Region	Light defoliation to mugho pine at Bracebridge Resource Management Centre, Bracebridge District.
European pine shoot moth *Rhyacionia buoliana* (Schiff.)	Red pine	St. Williams Forest Station, Simcoe District	A single compartment of 3-0 seedlings was heavily infested with overwintering larvae.
European snout beetle *Phyllobius oblongus* (Linn.)	Deciduous trees	Blind River District	High numbers evident in Lefroy and Bright townships.
European spruce sawfly *Gilpinia hercyniae* (Htg.)	White spruce	Sioux Lookout, Carleton Place, Brockville, Kirkland Lake, Kapuskasing, Cochrane, Chapleau, and Gogama districts.	Low numbers of trees attacked (1-10%) at trace defoliation levels (<5%) in several townships.

Ontario, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Eutypella canker *Eutypella parasitica* Davidson & Lorenz	Sugar maple Red maple	Algonquin Region	Surveys disclosed 4% of stems affected in Wood Township, Bracebrige District, and Killbear Provincial Park, Parry Sound District.
		Eastern Region	Infection levels ranging from 1.3-7.3% were recorded at scattered points throughout.
Fall cankerworm *Alsophila pometaria* (Harr.)	Basswood	North Bay District	Moderate levels of defoliation (30-40%) over 20 ha in Restoule Provincial Park.
Fall webworm *Hyphantria cunea* (Drury)	Hardwoods	Northeastern Region	Small pockets of heavy defoliation commonly noted.
		Northern Region	Pockets of light defoliation, but rarely noted.
		Algonquin, Central, and Southwestern regions	Populations generally dropped to low numbers and light defoliation.
		Eastern Region	Generally high populations in small pockets.
Fireweed rust *Pucciniastrum epilobii* Otth	Balsam fir	Chapleau District	Roadwide surveys disclosed 25% foliar damage to the entire sample at one location in Brutus Township.
Fire blight *Erwinia amylovora* (Burr.) Winslow et al.	Mountain ash	Cochrane District	A high incidence of infection was observed in the town of Iroquois Falls.
Flat leaftier *Psilocorsis reflexella* Clem.	Red oak Bur oak Trembling aspen	Algonquin and Central regions	Heavy infestations at many locations across Parry Sound, Bracebridge, Minden, and Lindsay Districts.
		Eastern Region	Foliar damage averaged 60% on 90% on hosts at Escott Township, Brockville District.
Fomes root rot *Heterobasidium annosum* (Fr.) Bref.	Red pine	Lindsay District	5% infection rate in 8 ha plantation of 14 m trees in Cartwright Township.
Gray willow leaf beetle *Pyrrhalta decora* (Say)	Willow	Chapleau and Kapuskasing districts	Severe defoliation occurred at several locations.
Greenheaded spruce sawfly *Pikonema dimockii* (Cress.)	White spruce	Carleton Place District	High populations caused 56% defoliation to a small clump of trees at Murphy's Point Provincial Park.
Greenstriped mapleworm *Dryocampa rubicunda* (Fabr.)	Red maple Sugar maple	Fort Frances District	Light infestations were detected from Reaves Lake to Barber Lake.
		Espanola District	Light-to-moderate foliar damage noted in two townships. Total area of infestation was 60 ha.
Hickory gall adelgid *Xerophylla caryaecaulis* (Fitch)	Bitternut hickory	Wingham District	Varying levels of branch mortality and 5% whole-tree mortality on 30% of mature trees in a 10 ha woodlot in Osborne Township.

Ontario, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Hickory twig pruner *Elaphidionoides*	Bitternut hickory Red oak	Eastern Region	Numerous locations of light and occasionally medium infestations.
Imported willow leaf beetle *Plagiodera versicolora* (Laich.)	Willow	Eastern Region	Severe foliar damage in Brighton Township, Napanee District, and Gloucester Township, Carleton Place District.
Ink spot of aspen *Ciborina whetzelli*	Trembling aspen	Northern Ontario	Trace damage at widely scattered points.
Introduced pine sawfly *Diprion similis* (Htg.)	Scots pine White pine	Huronia, Parry Sound, and Napanee districts	Low populations reported from single locations in each district.
Jack pine midge *Cecidomyia piniinopis* (O.S.)	Jack pine	Chapleau District	Numerous individuals suffered 10% branch tip mortality over a 10 ha site in Deans Township.
Jack pine resin midge *Cecidomyia resinicola* (O.S.)	Jack pine	Sudbury, Espanola, Temagami, Timmins, and Kirkland Lake districts	Severe damage to young trees at a number of locations.
Jack pine sawflies *Neodiprion pratti banksianae* Roh.	Jack pine	Sudbury, Blind River, and Geraldton districts	Low numbers at several locations.
Neodiprion p. paradoxicus Ross		Pembroke and Bancroft districts	Heavy infestations of 1986 declined to generally light infestations.
		North Bay District	Low numbers reported at Antoine Provincial Park.
		Bracebridge and Minden districts	Single location noted in each district, trace and moderate damage, respectively.
		Brockville, Napanee, Tweed, and Carleton Place districts Ignace District	Defoliation ranging from 20-77% reported at several areas on both ornamental and plantation trees. Single colony recovered in Fumiss Township.
Jack pine tip beetle *Conophthorus banksianae* McPherson	Jack pine	Blind River District	Heavy infestations recurred with incidence ranging from 25-58% and leader damage as high as 8% in Lane and Timbrell townships.
		Chapleau District	Leader damage of 8.5% noted in Langlois Township.
Larch casebearer *Coleophora laricella* (Hbn.)	European larch	Huronia District	Caused 50-70% foliar damage in plantations at two locations in West Gwillimbury Township.
Larch-poplar rust *Melampsora medusae* Thüm.	Tamarack	North Bay District	A 0.5 ha stand experienced 25% average foliar damage.
	Hybrid poplar	Brockville District	Present in several compartments of the G. Howard Ferguson Tree Nursery.
Larch sawfly *Pristophora erichsonii* (Htg.)	Larch	Thunder Bay District	Defoliation in a 20 ha stand near Little Kabaigon Lake averaged 80%. Elsewhere in the province extremely low populations.

Ontario, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Large aspen tortrix *Choristoneura conflictana* (Wlk.)	Trembling aspen	North Central	The area of moderate-to-severe defoliation declined from 233 560 ha in 1986 to 121 830 ha in 1987.
		Northeastern and North Central regions	Reduced populations consisting of small numbers of larvae and varying levels of defoliation reported at numerous locations.
Leaf blight *Septoria betulae* Pass.	White birch	Algonquin and Northeastern regions	Widespread moderate-to-severe foliar infections were recorded across much of the Algonquin Region and through the southern portion of the North Bay, Espanola, and Sudbury districts of the Northeastern Region.
Leaf blotch *Guignardia aesculi* (Peck.)	Horse chestnut	Southwestern Region	Regionwide, 69% of the ornamentals were affected and foliar damage averaged 22%.
Leaf rollers *Anacampsis innocuella* Zell. *Choristoneura rosaceana* (Harr.) *Enargia decolor* (Wlk.) *Orthosia hibisci* (Gn.)	Aspen White birch	Northeastern, Northern, and North Central regions	Low numbers of one or more of these pests were observed attacking one or both hosts at several locations in each region.
Leaf spot *Tubakia dryina* (Sacc.) B. Sutton	Red oak	Bancroft District	Roadside assessment disclosed 60% foliar damage on scattered individuals at one location.
	White oak	Brockville District	Complete foliar damage to a small group of trees in Wolford Township.
Leaf spot *Phyllosticta* spp.	Green ash	Dryden District	Severe foliar infections occurred on young trees at the Dryden Forest Station.
	Sugar maple	Bancroft District	Scattered trees having 100% foliar damage were observed in Herschel Township.
Leaf spot *Phyllosticta minima* (Berk. & Curt.) Underw. & Earle	Red maple	Minden District	Affected 75% of regeneration in Halls Lake area, Stanhope Township.
Linden looper *Erannis tiliaria* (Harr.)	Deciduous species	Terrace Bay District	A small medium infestation persisted near the town of Marathon.
		Northeastern Region	Light damage at a few locations.
		Parry Sound District	A small (0.25 ha) stand of beech sustained 75% defoliation in Christie Township.
Maple leafcutter *Paraclemensia acerifoliella* (Fitch.)	Sugar maple	Eastern and Algonquin regions	Severe damage in Laxton Township, Minden District as well as in Lanark and Rideau Townships, Carleton Place District.
			Populations declined to light levels in the Pembroke and Bancroft districts.
Maple leaf roller *Spargonothis acerivorana* Mack.	Maple	Bracebridge and Minden districts	Defoliation of 20% and 35% occurred in Morrison and Glamorgan townships, respectively.

Ontario, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Maple trumpet skeletonizer *Epinotia aceriella* (Clem.)	Maple	Napanee District	A 10 ha stand in Presqu'ile Provincial Park sustained 85% foliar damage on understorey trees and the lower crowns of mature trees; another 2 ha area in Hallowell Township suffered 65% defoliation.
Maple webworm *Tetralopha asperatella* (Clem.)	Sugar maple	Algonquin and Central Regions	Light-to-moderate damage was widespread in the Bracebridge, Minden, Parry Sound, and Lindsay districts.
		Eastern Region	Low populations near Yonge and Escott townships, Brockville District.
Mountain-ash sawfly *Pristiphora geniculata* (Htg.)	Mountain ash	Ignace, Red Lake Sioux Lookout, and Fort Frances districts	The incidence of attack ranged from 10%-100% and accompanying defoliation varied from 20-70%.
		Chapleau District	Variable defoliation up to 65%.
Needle blight *Lophodermella concolor* (Dearn.) Darker	Jack pine	Algonquin Park District	Roadside assessment at one location in White Township revealed 80% defoliation.
Needle blight *Lophophacidium dooksii* Corlett & R. Shoem.	White pine	Blind River District	Moderate foliar damage affecting scattered individuals in Poulin Township and Mississagi Provincial Park.
Needle blight *Kabatina thujae* A. Schneider & v. Arx var. *juniperi* (A. Schneider & v. Arx) Morlet var. *thujae*	Eastern white cedar	Minden District	Severe browning (>75%) of two hedges observed within town of Minden.
		Dryden District	New record established in northwestern Ontario on 1 m windbreak trees at the Dryden Forest Station.
Needle cast *Isthmiella faullii* (Darker) Darker	Balsam fir	Atikokan District	Up to 60% of the foliage of understorey trees at Prairie Portage damaged.
		Chapleau and Tweed districts	Light damage recorded at one location in each district.
Needle tier *Spargonothis sulfureana* Clem.	Red pine	Espanola District	Moderate levels of defoliation (30-40%) on 1.5-m trees in a 1 ha plantation in Allan Township.
Northern pine weevil *Pissodes approximatus* Hopk.	White pine Red pine	Algonquin Park, Pembroke and Chatham districts	Reported causing varying levels of mortality from 10-80%.
Oak leafmining sawfly *Profenusa lucifex* (Ross)	Oaks	Eastern Region	Accounted for varying levels of damage in small oak stands (1-5 ha).
Oak skeletonizer *Bucculatrix ainsliella* Murt.	Oak	Southwestern and Central regions	Larval populations declined to low numbers.
		Eastern Region	Widespread low populations.
Oak trumpet skeletonizer *Epinotia timidella* Clem.	Red oak	Minden, Carleton Place, and Sault Ste. Marie districts	Moderate defoliation of single stands in each district.

Ontario, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Oak webworm *Archips fervidanus* (Clem.)	Red oak	Sudbury District	Foliar damage to numerous individuals averaged 7% on mature trees in a 20 ha stand in Rutherford Township.
Orangestriped oakworm *Anisota senatoria* (J.E. Smith)	Bur oak	Simcoe and Aylmer districts	Moderate-to-severe defoliation (>25%) noted on numerous open-grown individuals.
Paleheaded aspen leaf roller *Compsolechia niveopulvella* Chamb.	Trembling aspen	Chapleau District	Defoliation to mature stands averaged 70-80% in scattered areas through the northwestern portion of the District.
Pear sawfly *Caliroa cerasi* (Linn.)	Deciduous ornamentals	Sault Ste. Marie District	Foliar damage as high as 75% occurred in the city of Sault Ste. Marie.
Pine false webworm *Acantholyda erythrocephala* (Linn.)	Pine	Central Region	High numbers caused 80-100% foliar damage in Essa Township, Huronia District, and Harvey Township, Lindsay District.
		Algonquin Region	Moderate-to-severe damage in plantations in Mayo, Carlow, and Monteagle townships, Bancroft District and Stanhope Township, Minden District.
		Carleton Place District	Defoliation of 63-92% in Fitzroy and Ramsey townships, respectively.
Pine gall weevil *Podapion gallicola* Riley	Red pine	Lindsay District	Caused branch mortality and small pockets of whole tree mortality in four plantations in Haldimand Township.
		Pembroke and Algonquin districts	Low numbers at two single locations.
Pine needle rust *Coleosporium asterum* (Dietel) Sydow	Jack pine Red pine	Algonquin, Eastern, and Northwestern regions	Up to 100% incidence but associated foliar damage was less than 5%.
		Northeastern, Northern, and North Central region	Trees affected ranged from 10% to 100% with accompanying foliar infections up to 35%.
Pine sawfly *Neodiprion maurus* Roh.	Jack pine	Ignace, Thunder Bay, and Fort Frances districts	Trace populations at single locations in each district.
Pine spittlebug *Aphrophora cribrata*	Conifer	Province-wide	Reported from numerous areas; generally, damage was not significant.
Pine tortoise scale *Toumeyella parvicornis* (Ckll.)	Jack pine	Thunder Bay District	A total of 25% of the trees in a small jack pine plantation in Oliver Township were heavily infected.
		Algonquin and Northern regions	Small numbers of heavily infested trees were scattered through the regions.
Poplar flea beetle *Altica populi* Brown and *Chrysomela* sp.	Balsam poplar	Northeastern Region	Moderate-to-severe damage in southern portion of the Region.
		Pembroke and Bancroft districts	Scattered moderate-to-severe damage noted. Pockets of severe browning scattered throughout.

Ontario, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Physiological needle droop	Red pine	Blind River District	Typical symptoms were observed in two separate plantations, with 38% of the trees affected at one location in Sturgeon Township.
Question mark *Polygonia interrogationis* (Fabr.)	White elm	North Bay District	Low levels of damage (15%) to branch tips on 10 m trees over a 5 ha area in Pedley Township.
Red pine cone beetle *Conophthorus resinosae* Hopk.	Red pine	Temagami District	High numbers reported in shoreline stands and on the islands of Lake Temagami.
		Algonquin Region	Common at trace levels wherever low vigour trees existed.
Red pine sawfly *Neodiprion n. nanulus* Schedl.	Red pine Jack pine	Brockville, Carleton Place, Algonquin Park, Thunder Bay, Atikokan, Ignace, Timmins, Temagami, Gogama, Kenora, and Dryden districts	Generally low and declining populations reported.
		Pembroke District	Low-to-moderate defoliation (20-25%) at single locations in Bromely and Westmeath townships.
Redheaded jack pine sawfly *Neodiprion virginianus* complex	Jack pine	Northern and Northeastern regions	Generally low populations.
Redheaded pine sawfly *Neodiprion lecontei* (Fitch)	Red pine Jack pine	Northeastern, Central, Algonquin, and Eastern regions	Varying levels of damage reported across affected portions of the province. Highest numbers reported in the Parry Sound District.
Rodent damage	White pine	Carleton Place District	Gnawing of main stems on young plantation trees (<2 m) killed 42% of all trees examined.
Root rot *Cylindrocladium floridanum* Sob. & C.P. Seym.	Black spruce Red pine	Brockville District	Seedling mortality as high as 20% in several compartments in the G. Howard Ferguson Forest Station.
Rusty tussock moth *Orgyia antiqua* (L.)	White spruce	North Bay District	An infestation in a commercial greenhouse, Widdifield Township, resulted in the loss of 60 trays of seedlings.
Saratoga spittlebug *Aphrophora saratogensis* (Fitch)	Red pine	Pembroke District	Moderate populations caused 2% tree mortality and 10% branch mortality in a small red pine plantation in Raglan Township.
Sawyer beetles *Monochamus* spp.	Jack pine Black spruce	Thunder Bay District	Heavy adult feeding caused approximately 10 ha of whole-tree mortality in a stand adjacent to a cutover.
		Ignace, Red Lake, and Sioux Lookout districts	A total of 40 ha of tree mortality due to adult feeding.

Ontario, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Shorthorned oakworm *Anisota finlaysoni* Riotte	Bur oak	Cambridge District	Open-grown mature trees suffered 80-100% defoliation over a wide area in Trafalgar Township.
Shoot blight *Sirococcus conigenus* (DC.) P. Cannon & Minter	Red pine	Dryden, Sioux Lookout, and Wawa districts	Single incidence of disease reported in each district, average rate of infection was 45%.
Shoot blight *Venturia macularis* (Fr.) E. Müller & v. Arx	Trembling aspen	Nipigon and Hearst districts	Heavy infections caused 80-90% shoot damage at some locations.
		Algonquin, North Central, Northern, and Northwestern regions	Generally low-to-moderate (<25%) terminal infections were observed.
Solitary oak leafminer *Cameraria hamadryadella* (Clem.)	White oak	Eastern Region	Moderate levels of defoliation (20-50%) in concert with the oak spangles *Cecidomyia* spp. at a number of locations.
Spiny ash sawfly *Euparcophora parca* (Cress.)	Black ash	Atikokan, Chapleau, Gogama, Kirkland Lake, and Tamagami districts	Light and medium infestations at several locations.
Spruce bud moth *Zeiraphera canadensis* Mut. & Free.	White spruce	Pembroke, Bancroft, Cornwall, Brockville, Chapleau, Sudbury, and Thunder Bay districts	Light-to-medium infestations.
Spruce needle rusts *Chrysomyza ledi* (Alb. & Schwein.) de By. and *C. ledicola* Lagerh.	Spruce	Red Lake, Terrace Bay, and Sudbury districts	Several significant infestations at moderate (30-50%) damage levels.
		North Central and Northeastern regions	Trace-to-low levels of damage (1-5%) commonly encountered.
Spruce spider mite *Oligonychus ununguis* (Jac.)	White spruce Eastern white cedar	Maple District	High populations found frequently on ornamentals through the district.
Sugar maple borer *Glycobius speciosus* (Say)	Sugar maple	Eastern Region	Present in all stands examined at damage levels ranging from 1-7%.
Swaine jack pine sawfly *Neodiprion swainei* Midd.	Jack pine	Temagami District	Varying damage levels at numerous locations.
		Sudbury District	Small numbers of colonies at several locations.
Sweet fern blister rust *Cronartium comptoniae* Arthur	Jack pine	Fort Frances District	High incidence of stem cankers (14.6%) at a single location near Turtle Station.
		Kenora, Ignace, and Chapleau districts	Low levels (<3%) of infections were noted at several locations.
Tar spot needle cast *Davisomycella ampla* (J. Davis) Darker	Jack pine	Northeastern, Northern, Northwestern, and Algonquin regions	A light incidence (<25%) with associated foliar infections of up to 80%.

Ontario, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Tip blight *Sphaeropsis sapinea* (Fr.) Dyko & B. Sutton	Scots pine Red pine	Maple, Cambridge, and Huronia districts	Increased levels of infections frequently noted.
		Simcoe District	A single 20 ha private plantation had high levels of branch mortality (60%) on 80% of trees surveyed.
		Brockville and Napanee districts	High levels of infection at single locations in the cities of Kingston and Ottawa.
		Blind River and Wawa districts	A single heavy ifnection noted in each district; rate of infection at both locations was 80%.
Tomentosus root rot *Inoonotus tomentosus* (Fr.) Gilbertson	White birch	Kapuskasing District	One infected compartment at the Bonner Tree Improvement Centre.
Twig canker *Foveostroma abietinum* (Peck) DiCosmo	Balsam fir	Wawa District	Cankers present on 30% of the regeneration at Agawa Bay in Lake Superior Provincial Park.
Walnut caterpillar *Datana integerrima* G. & R.	Walnut	Chatham, Aylmer, and Simcoe districts	Foliar damage averaged 17% on 51% of all trees examined.
Webspinning sawfly *Cephalcia* spp.	Red pine	Dryden, Fort Frances, and Kenora districts	Low levels of foliar damage (10%) noted in several townships.
Western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hirat.	Jack pine Scots pine	Northeastern and Northwestern regions	Increased incidence of this disease reported in several areas.
		Pembroke and Cornwall districts	Single occurrence in each district with low incidence of infected trees (<3%).
White pine blister rust *Cronartium ribicola* J.C. Fisch.	White pine	Espanola, North Bay, and Aylmer districts	Levels of stem cankers (<5%) infrequently noted in young plantations.
		Carleton Place District	Single incidence of 10% stem cankers in North Elmsley Township.
White pine cone beetle *Conophthorus coniperda* (Sz.)	White pine	Parry Sound District	Heavy infestations on several islands in the Sans Souci area of Georgian Bay.
White pine sawfly *Neodiprion pinetum* (Nort.)	White pine	Napanee District	Single location with several colonies at trace damage levels (5%) in Pittsburg Township.
White pine weevil *Pissodes strobi* (Peck)	Pine Spruce	Northern Ontario	Populations generally up across the area. The highest incidence occurred in Michie Township, Kirkland Lake District, and in Invergarry Township, Gogama District where 37% and 29% of leaders, respectively, were affected.

Ontario, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
		Southern Ontario	Populations varied considerably with no distinct population trends. Highest number of infested leaders (60%) observed was in a 2 ha, 3.8 m experimental Norway spruce plantation, located at the Petawawa National Forestry Institute.
Willow flea weevil *Rhynchaenus rufipes* (Lec.)	Willow	Eastern Region	Total defoliation (100%) of willow clumps at numerous locations.
Willow leafminer *Micrurapteryx salicifoliella* Cham.	Willow	Northern Region, Geraldton, Nipigon, and Terrace Bay districts	Moderate-to-severe leafmining at numerous locations throughout.
Woolly alder sawfly *Eriocampa ovata* (Linn.)	Alder	Thunder Bay and Dryden districts	Severe defoliation (>75%) in several townships.
Yellowheaded spruce sawfly *Pikonema alaskensis* (Roh.)	White spruce Black spruce	Northeastern Region	Light damage in scattered areas.
		North Central Region	Moderate-to-severe damage in several areas of Atikokan, Thunder Bay, and Geraldton districts.
		Northern Region	High numbers at various locations.
		Central Region	Moderate defoliation (50-60%) in Essa and Tiny townships.